Appendix
A

Frederick County
Maryland

Energy Management
Assessment Study

Citizens Services Building
Courthouse Complex
Public Works Office Building
Health Department
Law Enforcement Center
Urbana Library & Senior Center
Transit Center
Westview Fire Station

Submitted by:
CQI Associates

Report Date:
April 8, 2009

Frederick County
Maryland

Energy Management Assessment Study

Introduction

Frederick County Government requested that CQI Associates, LLC provide consulting services to assist in the development of Energy Management Assessment Studies for the following buildings:

Citizens Services Building
Courthouse Complex
Public Works Office Building
Health Department
Law Enforcement Center
Urbana Library & Senior Center
Transit Center
Westview Fire Station

The goal of this study is to provide assistance to Frederick County to develop recommendations for energy management programs to reduce energy consumption and costs.

CQI's Energy Management Assessment Study was designed to:

- Evaluate current energy use and planned improvements.
- Analyze energy bills for the previous 12 months.
- Develop an energy cost and consumption baseline for each facility.
- Evaluate the results of energy conservation programs and projects implemented to date.
- Evaluate the operating plans and budget for the next three to five years.
- Evaluate capital improvement plans for the next six years.

- Conduct a walk-through site assessment of each facility with the following objectives:

  The site assessments were conducted starting March 2008 and completed July 2008.

  - Identify energy management program operation and project improvements to be implemented.
  - Identify programs and projects that could result in consumption reductions including employee behavior modification, equipment operation improvements, maintenance practice improvements, and low-cost retrofit projects for the next two years.
  - Identify capital improvement projects that will produce long-term savings for the subsequent six-year period.

- Based on the results of the evaluation of the above, develop a plan as follows:

  - Identify programs and projects that could reduce consumption and costs (savings/avoidance) for the next two years to include employee behavior modification tasks, equipment operations improvements, maintenance practice improvements, and low-cost retrofit projects.
  - Identify energy retrofit projects to improve energy efficiency for the subsequent three to five year period.
  - Identify capital improvement projects that will produce long-term savings for the subsequent three to five year period.
  - Identify energy supply procurement practices that can be implemented over the next 12 to 24 month period for the applicable energy supply services.
  - Identify programs to expand staff capabilities to manage and implement the programs.
  - Develop energy cost projections for the next five years based on the proposed recommendations.
  - Develop a proposed budget and schedule for implementing the proposed recommendations.

- Submit an Energy Management Assessment Study Report with recommendations and chart for each facility.

Baseline Year - 2007 Energy Costs

The 2007 energy usage for the eight buildings was used as the baseline for development of the recommendations for this report.

The actual cost and consumption data for the buildings for the calendar year 2007 (January 2007 to December 2007) is as follows:

Citizens Services Building

Annual Energy Usage and Cost	**Amount**	**Units**	**Annual Cost**	**Unit Cost**
Electricity Service	591,120	kWh	$44,536	$0.075
Gas Service	34,264	therm	$43,323	$1.264
		Total	**$87,859**	

Cost Per Square Foot	Square Feet	25,742	Cost per sf.	**$3.41**

Courthouse Complex

Annual Energy Usage and Cost	**Amount**	**Units**	**Annual Cost**	**Unit Cost**
Electricity Service	3,582,910	kWh	$270,712	$0.076
		Total	**$270,712**	

Cost Per Square Foot	Square Feet	194,189	Cost per sf.	**$1.39**

Public Works Office Building

Annual Energy Usage and Cost	**Amount**	**Units**	**Annual Cost**	**Unit Cost**
Electricity Service	335,200	kWh	$26,048	$0.078
Gas Service	3,544	therm	$5,263	$1.485
		Total	**$31,312**	

Cost Per Square Foot	Square Feet	24,400	Cost per sf.	**$1.28**

Health Department

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	1,054,870	kWh	$80,568	$0.076
Gas Service	2,883	therm	$4,319	$1.498
		Total	**$84,888**	

Cost Per Square Foot	Square Feet	62,210	Cost per sf.	**$1.36**

Law Enforcement Center

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	2,156,137	kWh	$158,931	$0.074
Gas Service	44,114	therms	$57,212.	$1.297
		Total	**$216,144**	

Cost Per Square Foot	Square Feet	70,325	Cost per sf.	**$3.07**

Urbana Library & Senior Center

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	646,181	kWh	$74,741	$0.116
Gas Service	16,145	therm	$21,338	$1.322
		Total	**$96,079**	

Cost Per Square Foot	Square Feet	31,060	Cost per sf.	**$3.09**

Transit Center

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	292,640	kWh	$29,412	$0.101
Gas Service	9,938	therm	$13,808	$1.389
		Total	**$43,221**	

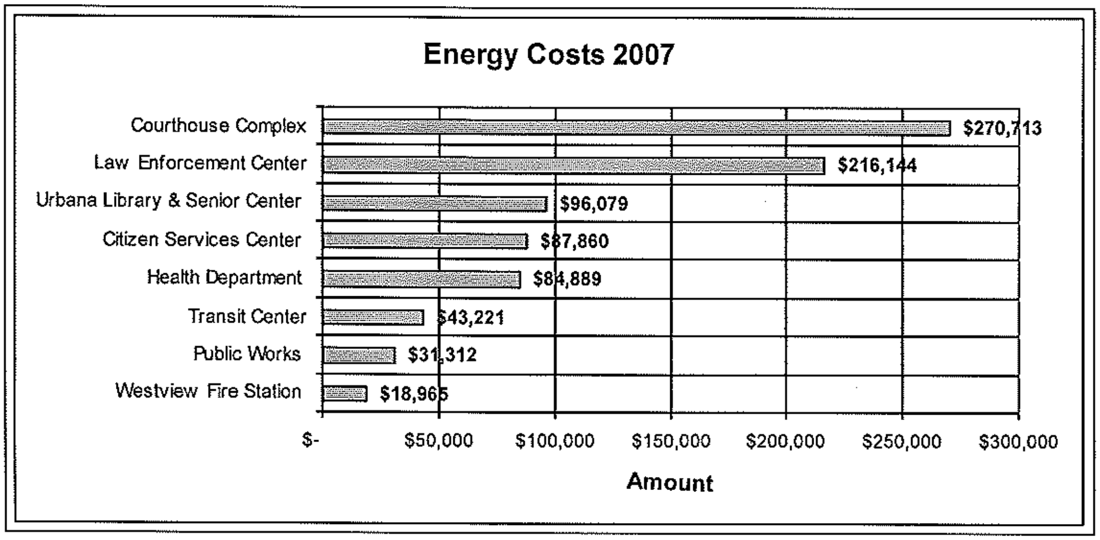
Cost Per Square Foot	Square Feet	13,551	Cost per sf.	**$3.19**

Westview Fire Station

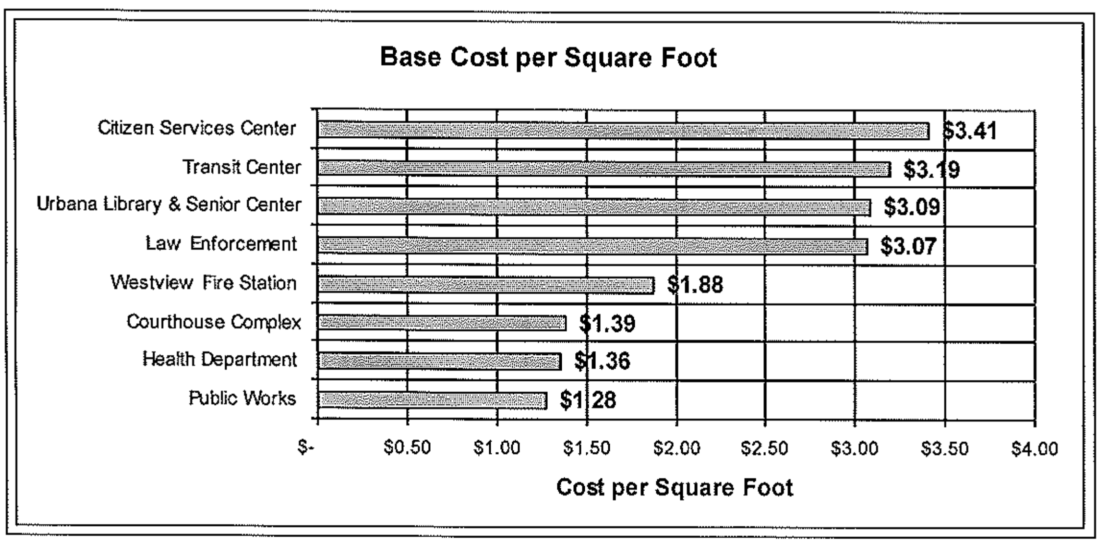
Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	174,880	kWh	$17,666	$0.101
Gas Service	781	therm	$1,297	$1.662
		Total	$18,964	

Cost Per Square Foot	Square Feet	10,078	Cost per sf.	$1.88

The following chart shows the buildings ranked by annual energy cost:



The following chart shows the buildings ranked by cost per square foot:

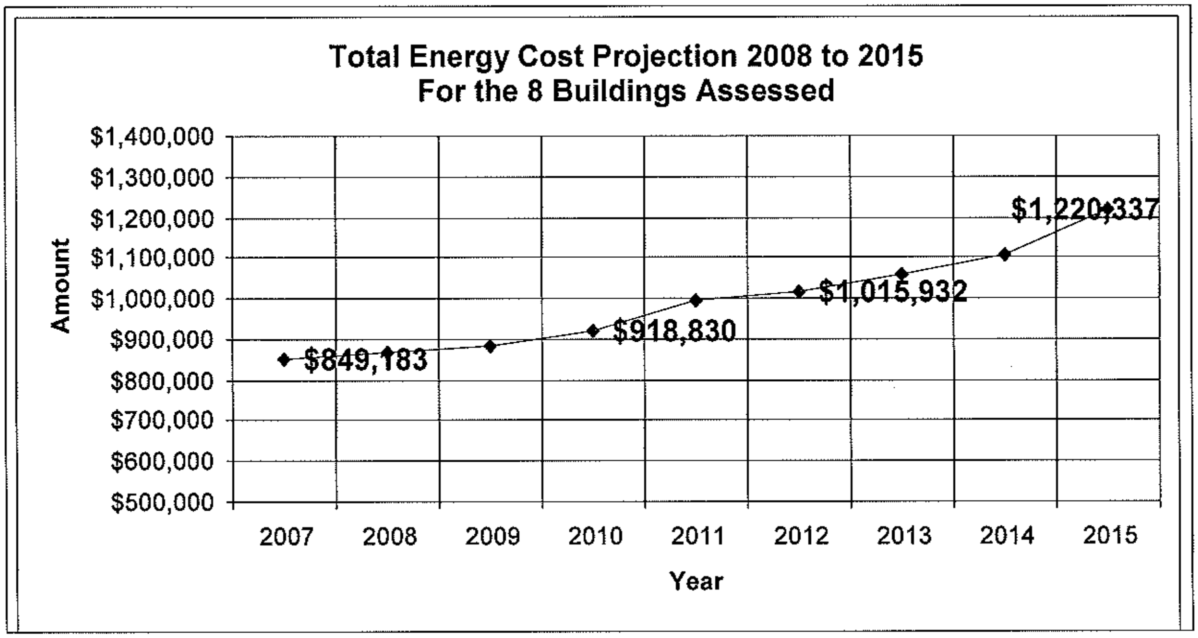


Energy Cost Projection – 2008 to 2015

The following projections assume no energy management programs are implemented. The projections assume that electricity and natural gas procurement contracts will be obtained and signed.

2007	2008	2009	2010	2011	2012	2013	2014	2015
$849,183	$866,167	$883,490	$918,830	$996,012	$1,015,932	$1,056,569	$1,109,398	$1,220,337

The chart showing the above projections if no energy management programs were implemented for these buildings follows.



Recommendations:

CQI conducted site assessments of the eight Frederick County buildings to study current practices and operations and to identify areas for improvement.

The recommendations are cost-effective programs and projects that can be implemented with a reasonable financial investment to meet the overall program goals.

Citizens Services Building

The building's cooling and heating systems operate simultaneously 24 hours a day, 7 days a week. Natural gas consumption (49%) is about equal to electricity consumption (51%). The percentages *should be* 75% for electricity and 25% for natural gas. The current cost is $3.41 per square foot which is $1.50 per square foot higher than a comparable building.

The building has had humidity and moisture problems that resulted in the proposed solution to operate the building in the current mode. The primary recommendation would be to adjust the temperature controls and operation hours to reduce cooling and heating system consumption.

The long-term solution would be to either add additional temperature controls that allow the operating hours to be adjusted when the humidity and moisture percentages are within preferred design guidelines, or redesign and renovate the building HVAC system.

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	591,120	kWh	$44,536	$0.075
Gas Service	34,264	Therm	$43,323	$1.264
		Total	**$87,859**	

Cost Per Square Foot	Square Feet	25,742	Cost	$3.41

Short Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Adjust Programmable Thermostats for occupied and unoccupied settings	Facility Wide	$0	$1,000	0.0
Install lighting occupancy sensors, storerooms, mechanical rooms, work rooms, rest rooms and selected areas	Facility Wide	$1,000	$500	2.0
Demand monitoring & reduction to change major equipment schedules to reduce demand by 20 kw per billing period	20 kW	$0	$2,000	0.0
Replace incandescent bulbs with compact florescent bulbs	Facility Wide	$600	$800	0.8
Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$700	$1,200	0.6

Totals	**$2,300**	**$5,500**	**0.4**
Annual Operating Savings Percentage		6%	
Revised Operating Cost Projection		**$82,360**	
Cost Per Square Foot	25,742	**$3.20**	

Long Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Install a Variable Speed Drive on the Chiller	2	$9,800	$2,600	3.8

(Building requires cooling and heating at the same time. The result is excess natural gas consumption.) Install additional controls to modulate the amount of heat required in the summer and cooling in the winter	1 – Option A	$26,000	$14,000	1.9
HVAC renovation recommended to control temperature and humidity - Proposed facility renovation is in the Capital Budget Plan within 5 years	Facility Wide – Option B	$350,000	$17,500	20.0
	Totals	**$385,800**	**$34,100**	
	Annual Operating Savings Percentage		39%	

Revised Operating Cost Projection		**$48,260**
Cost Per Square Foot	25,742	**$1.87**

Total Program	**$388,100**	**$39,600**	**9.8**
Annual Operating Cost Savings Percentage		**45%**	

Courthouse Complex

The current HVAC system's age exceeds the manufacturer's recommended normal useful life and efficiency.

The 2007 energy cost per square foot for this facility was $1.39. The energy costs are half the cost of other compatible County Courthouse facilities in Maryland. Similar Courthouse facilities energy costs are on average $2.50 per square foot.

CQI Associates is concerned that the costs for this building could increase when the existing HVAC systems are replaced or upgraded.

An engineering study needs to be conducted prior to the replacement of the HVAC units to verify the long-term operating cost impact.

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	3,582,910	kWh	$270,712	$0.076
		Total	**$270,712**	

Cost Per Square Foot	Square Feet	194,189	Cost	$1.39

Short Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Replace Lighting in Garage	25	$7,200	$3,100	2.3
Control Exhaust Fans in Garages based on CO2 levels	2	$1,200	$600	2.0
Replace bulb type exit fixtures with LED bulb fixtures	Facility Wide	$1,200	$1,800	0.7
Reset controls on unit heaters to not exceed 55 degrees	6	$0	$450	0.0
Install lighting occupancy sensors, storerooms, mechanical rooms, work rooms, rest rooms and selected areas	Facility Wide	$1,000	$600	1.7
Demand monitoring & reduction to change major equipment schedules to reduce demand by 40 kW per billing period	40 kW	$0	$3,000	0.0
Control individual units for the old system	7	$4,000	$1,500	2.7
	Totals	**$14,600**	**$11,050**	**1.3**
	Annual Cost Savings Percentage		4%	

Revised Operating Cost Projection	**$259,663**

Cost Per Square Foot	194,189	**$1.34**

Long Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Replace T-8 light fixtures and bulbs with LED fixtures and bulbs in Atrium & Lobby	150	$60,000	$8,000	7.5
Expand Energy Management System	Facility Wide	$20,000	$10,000	2.0
Roof-top HVAC Unit Replacements proposed in the Capital Budget Plan	6	$350,000	**$35,000**	10.0
	Totals	**$430,000**	**$53,000**	**8.1**
	Annual Operating Cost Savings Percentage		20%	

Revised Operating Cost Projection		**$206,663**
Cost Per Square Foot	194,189	**$1.06**

Total Program	**$444,600**	**$64,050**	**6.9**
Annual Operating Cost Savings Percentage		**24%**	

Public Works Office Building

The recent renovation of the building has improved the facility's energy efficiency. There are a few remaining T-12 light fixtures in the building that need to be replaced, and repairs are needed to the relief air dampers on the roof top units. When the short-term projects are completed, the building will be as efficient as possible given the original age of the facility.

No long-term projects were identified.

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	335,200	kWh	$26,048	$0.078
Gas Service	3,544	Therm	$5,263	$1.485
		Total	**$31,312**	

Cost Per Square Foot	Square Feet	24,400	Cost	$1.28

Short Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Replace remaining T-12 light in stairways fixtures and bulbs with T-8 fixtures and bulbs	24	$3,600	$1,300	2.8
Roof Top Unit Relief Air Damper Controls need to modified and controls setting improved	4	$3,000	$1,000	3.0
Replace hot water tank units with insta-heat and tankless water heaters	2	$1,600	$800	2.0
Install lighting occupancy sensors in storerooms, mechanical rooms, work rooms, rest rooms and selected areas	10	$1,200	$500	2.4
Demand monitoring & reduction to change major equipment schedules to reduce demand by 10 kW per billing period	10 kW	$0	$1,300	0.0
Replace incandescent bulbs with compact florescent bulbs	Facility Wide	$600	$800	0.8
Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$300	$500	0.6
	Totals	**$10,300**	**$6,200**	**1.7**
	Annual Operating Cost Savings Percentage		20%	

Revised Operating Cost Projection **$25,112**

Long Term Projects **None Proposed**

Total Program	**$10,300**	**$6,200**	**1.7**
Annual Operating Cost Savings Percentage		**20%**	

Health Department

The basic design of the primary cooling and heating systems are acceptable and efficient. Short-term recommendations focus on completing the upgrade of the thermostats in the remaining temperature control zones. The hall lights should be converted to compact florescent bulbs. The long-term recommendation is to install variable frequency drives on the primary pumps and fan systems.

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	1,054,870	kWh	$80,568	$0.076
Gas Service	2,883	Therm	$4,319	$1.498
		Total	**$84,888**	

Cost Per Square Foot	Square Feet	62,210	Cost	$1.36

Short Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Replace 75 watt hall lights with 23 watt compact florescent bulbs	Halls	$600	$800	0.8
Upgrade remainder of the thermostat controls to the new zoned sensors tied to a main control unit and the EMS	6	$9,800	$3,200	3.1
Control Parking Lot Lights by timers and re-wiring to accommodate unoccupied period of the day	6	$2,500	$900	2.8
Install lighting occupancy sensors in storerooms, mechanical rooms, work rooms, rest rooms and selected areas	10	$600	$300	2.0
Demand monitoring & reduction to change major equipment schedules to reduce demand by 10 kW per billing period	10 kW	$0	$600	0.0
Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$800	$1,200	0.7
	Totals	**$14,300**	**$7,000**	**2.0**
	Annual Operating Cost Savings Percentage		8%	

Revised Operating Cost Projection		**$77,889**

Cost Per Square Foot	62,210	$1.25

Long Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Install VFD' on Pumps and Fans	3	$30,000	$6,000	5.0
	Totals	$30,000	$6,000	5.0
	Annual Operating Savings Percentage		7%	

Revised Operating Cost Projection		$71,889
Cost Per Square Foot	62,210	$1.16

Total Program	$44,300	$13,000	3.4
Annual Operating Cost Savings Percentage		15%	

Law Enforcement Center

The center is comprised of a number of operations. They are served by a central cooling and heating system. The occupancy times of the various operations run from 24 hours a day, 7 days a week in the 911 centers and command center, to 48 hours a week in the administrative office areas. The building layout does not group operations that have the same hours of occupancy in the same temperature control zones.

The vehicle maintenance building operates only on average of 48 hours a week, but is connected to the main building for cooling and heating. This causes additional demand on the central system especially in winter.

The central cooling and heating system is required to operate 24 hours a day, 7 days a week even though major portions of the building and vehicle maintenance building operate only half of the time.

Every effort should be made to control temperatures and operations of the units in zones thus eliminating the need to run the central plant at full capacity at night and on weekends.

The building has an emergency generator that can operate all the building systems. The utility grid management system, PJM Interconnection, offers a demand response program to large customers with the capability to reduce electricity load during peak load demand days. The grid will pay participants on average $35,000 per megawatt to shed load during the peak periods especially in the summer. Participation in this program should be investigated further and implemented by the spring of 2009.

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	2,156,137	kWh	$158,931	$0.074
Gas Service	44,114	therms	$57,212	$1.297
		Total	**$216,144**	

Cost Per Square Foot	Square Feet	70,325	Cost	$3.07

Short Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Replace remaining T-12 light fixtures and bulbs with T-8 fixtures and bulbs in mechanical rooms and elevator	34	$4,000	$2,700	1.5
Replace Metal Halide Lighting in shop: 400 watt high bay with six-bulb T-8 fixtures to reduce to 192 watts.	20	$9,500	$3,000	3.2
Install Ambient Light Sensors in Stairways	26	$1,600	$900	1.8
Install Ambient Light Sensors in Lobby	6	$800	$600	1.3
Program zoned night setback for selected administrative area and the main meeting room on the EMS	4	$8,000	$6,000	1.3
Install a separate unit for nights and weekends for the Command Center. Program the remaining floor and office zone for night setback on the EMS	1	$6,000	$2,800	2.1
Install a separate unit for nights and weekends for the Dorm unit for each room and area. Remove from the remaining floor and office zone on the EMS	4	$12,000	$4,500	2.7
Install lighting occupancy sensors, storerooms, mechanical rooms, work rooms, rest rooms and selected areas	10	$1,500	$800	1.9

Demand monitoring & reduction to change major equipment schedules to reduce demand by 50 kW per billing period	50 kW	$0	$2,900	0.0
Replace hot water tank units with insta-heat and tankless water heaters	4	$2,700	$900	3.0
Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$1,800	$2,700	0.7
	Totals	**$47,900**	**$27,800**	**1.7**
	Annual Operating Cost Savings Percentage		13%	
	Revised Operating Cost Projection		**$188,344**	

Long Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Enroll Building in PJM Demand Response Program and Run the building on the generator when requested by Allegheny Power	1 MW Load	$0	$30,000	0.0
	Totals	**$0**	**$30,000**	
	Annual Operating Savings Percentage		14%	
	Revised Operating Cost Projection		**$158,344**	

Total Program	**$47,900**	**$57,800**	**0.8**
Annual Operating Cost Savings Percentage		27%	

Urbana Library & Senior Center

The library is new but the system does not operate efficiently due to the following:

- Energy Management Control Programs are not functioning properly or within the design guidelines. Temperatures vary throughout the building during the day. The control programming is not able to maintain set points and uniform temperatures. The offices are overheating on a continuous basis even in the summer.

- No provisions were allowed in the design to exhaust return air from the air handling units. Proper mixing of fresh air with return air ensures occupant health and comfort. Efficient mixing of return air and fresh air reduce energy costs. The contractor removed a section of duct work to provide a short term solution. The impact of the fix is an un-controlled exhaust of the tempered return air requiring more energy to bring in the fresh air. The chiller and the boilers are operating continuously to maintain the space temperatures to meet the design requirements, but the process is not efficient especially for a new building.

- The chillers, separate roof-top HVAC units, and the boilers are running continuously and not able to be cycled back. The control temperature problems seem to be the primary cause.

The building should be operating at a lower cost per square foot based on the application of the current ASHRAE standards. The costs could be 25% less based on the U.S. Environmental Agency Profile Manager Program.

The primary recommendation for this building is to re-program the Energy Management System and to repair/redesign the return air duct system.

CQI Associates has proposed an Option A and Option B for this building. Option B would remove the front end program controller for the Energy Management System and replace it with an open protocol programmable unit. The time that it may take to fix the program problem with the current controls system could be solved by replacing the system with a new unit programmed properly from the factory. The additional costs will be offset by quickly resolving the temperature and operating problems in a quarter of the time.

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	646,181	kWh	$74,741	$0.116
Gas Service	16,145	Therm	$21,338	$1.322
		Total	**$96,079**	

Short Term Projects - Option A				
Projects	**Number**	**Total Investment**	**Annual Savings**	**Payback Period (Years)**
Reset hot water temperature settings to 120 degrees	1	$0	$450	0.0
Re-duct the return air exhaust to the outside of the mechanical room	2	$12,000	$2,500	4.8
Re-calibrate the control settings on the Energy Management System to function correctly according to the design specifications	Facility Wide **- Note Option B**	$15,000	$3,700	4.1
Re-calibrate the control settings on the Energy Control for the units in the Senior Citizens Area. Reheat Units to include the humidification units controllers	6 **- Note Option B**	$3,000	$900	3.3
Install time-clock or occupancy based CO2 sensor in the lower level conference room to turn the system off when not occupied during the daytime.	1	$1,500	$750	2.0
Replace hot water tank units with insta-heat and tankless water heaters	3	$1,600	$400	4.0
Demand monitoring & reduction to change major equipment schedules to reduce demand by 20 kW per billing period	20 kW	$0	$1,100	0.0
Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$1,000	$1,500	0.7
	Totals	**$34,100**	**$11,300**	**3.0**
	Annual Operating Cost Savings Percentage		12%	

Revised Operating Cost Projection		**$84,779**
Cost Per Square Foot	31,060	**$2.73**

Long Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Install a VFD unit on Chiller	Facility Wide	$10,000	$3,100	3.2
	Totals	**$10,000**	**$3,100**	**3.2**
		Annual Operating Savings Percentage	3%	

Revised Operating Cost Projection		**$81,679**
Cost Per Square Foot	31,060	**$2.63**

Total Program	**$44,100**	**$14,400**	**3.1**
Annual Operating Savings Percentage		**15%**	

Short Term Projects - Option B – RECOMMENDED				
Projects	**Number**	**Total Investment**	**Annual Savings**	**Payback Period (Years)**
Reset hot water temperature settings to 120 degrees	1	$0	$450	0.0
Re-duct the return air exhaust to the outside of the mechanical room	2	$12,000	$2,500	4.8
Remove the Energy Management System master control unit and replace with a new unit with open program protocol programming capability and reconfigure the control programs for all existing points	Facility Wide **Alternative**	$50,000	$18,000	2.8
Install time-clock or occupancy based CO2 sensor in the lower level conference room to turn the system off when not occupied during the daytime.	1	*Included*	*Included*	

Replace hot water tank units with insta-heat and tankless water heaters	3	$1,600	$400	4.0
Demand monitoring & reduction to change major equipment schedules to reduce demand by 20 kW per billing period	20 kW	$0	$1,100	0.0
Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$1,000	$1,500	0.7
	Totals	**$64,600**	**$23,950**	**2.7**
	Annual Operating Savings Percentage		25%	
	Revised Operating Cost Projection		**$72,129**	
Cost Per Square Foot		31,060	**$2.32**	

Transit Center

This facility operates from 3:30 am to 10:30 pm daily. The shops and service areas add to the cost of the operation of the complex. Not all the units are programmed for zoned night setback. The area occupied during traditional business hours needs to be zoned and programmed to allow for set-back of temperatures when not occupied. The shop temperatures should be included.

The primary project for this facility is the replacement of the metal halide lighting in the garage with T-8 fixtures and bulbs.

No long-term projects were identified for this facility.

Annual Energy Usage and Cost	Amount	Units	Annual Cost	Unit Cost
Electricity Service	292,640	kWh	$29,412	$0.101
Gas Service	9,938	therm	$13,808	$1.389
		Total	**$43,221**	

Cost Per Square Foot	Square Feet	13,551	Cost	$3.19

Short Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Install Programmable Thermostats on natural gas fired radiant heaters in garage & parts storage with seven day occupied and unoccupied units	8	$1,200	$1,100	1.1
Recalibrate the RTU heating to insure the temperature setting do no exceed the set points especially in the winter	4	$0	$900	0.0
Replace Metal Halide Lighting in shop: 400 watt high bay with six-bulb T-8 fixtures to reduce to 192 watts.	28	$9,800	$3,500	2.8
Replace Metal Halide Lighting in fueling area under canopy: 250 watt high bay with four bulb T-8 fixtures to reduce to 64 watts.	4	$1,600	$600	2.7
Install programmable timer on the air compressor to turn unit off when the shop is closed	1	$350	$275	1.3
Replace hot water tank units with insta-heat and tankless water heaters	2	$1,200	$500	2.4
Demand monitoring & reduction to change major equipment schedules to reduce demand by 30 kW per billing period	30 kW	$0	$440	0.0
Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$400	$520	0.8
	Totals	**$14,550**	**$7,835**	**1.9**
	Annual Operating Savings Percentage		18%	

Revised Operating Cost Projection		**$35,386**
Cost Per Square Foot	13,551	**$2.61**

Long Term Projects	**None Proposed**

Total Program	**$14,550**	**$7,835**	**1.9**
Annual Operating Savings Percentage		**18%**	

Westview Fire Station

The fire station, on a cost per square foot basis and operating temperature basis, is efficient when compared to similar facilities. The natural gas service use is very low and is not what was expected given that the garage area is heated by radiant heaters.

The primary recommendation is to insure proper temperature settings for occupied and unoccupied use of the building. The dorm temperatures were set at 65 degrees and were unoccupied in the day time. This thermostat should be set to an occupied setting at night and unoccupied in the daytime.

The primary project for this facility is the replacement of the metal halide lighting in the garage with T-8 fixtures and bulbs.

Annual Energy Usage and Cost	**Amount**	**Units**	**Annual Cost**	**Unit Cost**
Electricity Service	174,880	kWh	$17,666	$0.101
Gas Service	781	Therm	$1,297	$1.662
		Total	**$18,964**	

Cost Per Square Foot	Square Feet	10,078	Cost	$1.88

Short Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Adjust Programmable Thermostats for occupied and unoccupied settings	Facility Wide	$0	$1,800	0.0
Install Programmable Thermostats on natural gas fired radiant heaters in garage with seven day occupied and unoccupied units	4	$500	$250	2.0
Install lighting occupancy sensors in storerooms mechanical rooms, work rooms, rest rooms and selected areas	10	$600	$500	1.2
Replace Metal Halide Lighting: 400 watt high bay with six-bulb T-8 fixtures to reduce to 192 watts.	16	$7,600	$2,500	3.0

Lighting Wattage Reduction: convert over the next 12 months from 32 watt T-8 bulbs to compatible 28 watt T-8 bulbs	Facility Wide	$200	$300	0.7

Totals	**$8,900**	**$5,350**	**1.7**
Annual Operating Savings Percentage		28%	

Revised Operating Cost Projection		**$13,614**
Cost Per Square Foot	10,078	**$1.35**

Long Term Projects

Projects	Number	Total Investment	Annual Savings	Payback Period (Years)
Replace hot water tank units with insta-heat and tankless water heaters within five years since the current tanks are still operational	3	$1,600	$200	8.0
	Totals	**$1,600**	**$200**	8.0
	Annual Operating Savings Percentage		1%	

Revised Operating Cost Projection		**$13,414**
Cost Per Square Foot	10,078	**$1.33**

Total Program	**$10,500**	**$5,550**	**1.9**
Annual Operating Savings Percentage		**29%**	

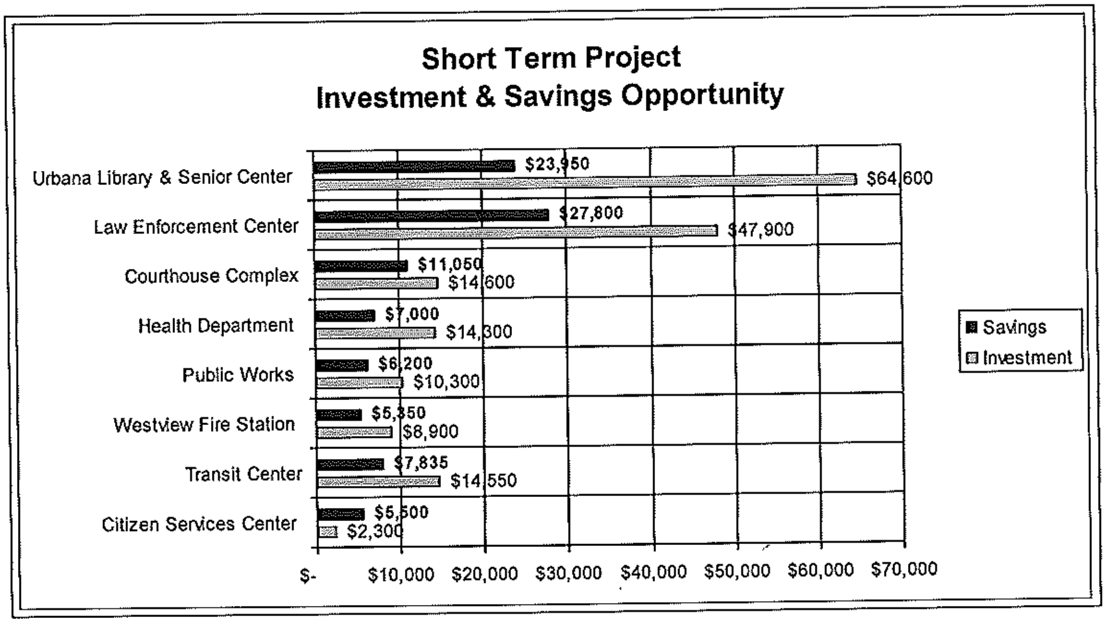
Conclusion

The proposed program recommendations for the list of short-term projects will result in reducing costs as follows:

Short-Term Projects	Annual Energy Costs	Total Investment	Annual Savings	Payback Period (Years)
Citizen Services Center	$87,860	$2,300	**$5,500**	0.4
Courthouse Complex	$270,713	$14,600	**$11,050**	1.3
Public Works Office Bldg.	$31,312	$10,300	**$6,200**	1.7
Health Department	$84,889	$14,300	**$7,000**	2.0
Law Enforcement	$216,144	$47,900	**$27,800**	1.7
Urbana Library & Senior Center - Option B	$96,079	$64,600	**$23,950**	2.7
Transit Center	$43,221	$14,550	**$7,835**	1.9
Westview Fire Station	$18,965	$8,900	**$5,350**	1.7
Totals	$849,183	**$177,450**	**$94,685**	**2.3**

The short-term recommendation is to invest $177,450 and save $94,685 per year within a 2.3 year payback period.

The annual savings would be 11.2%



The estimated long-term recommendations and financial results are:

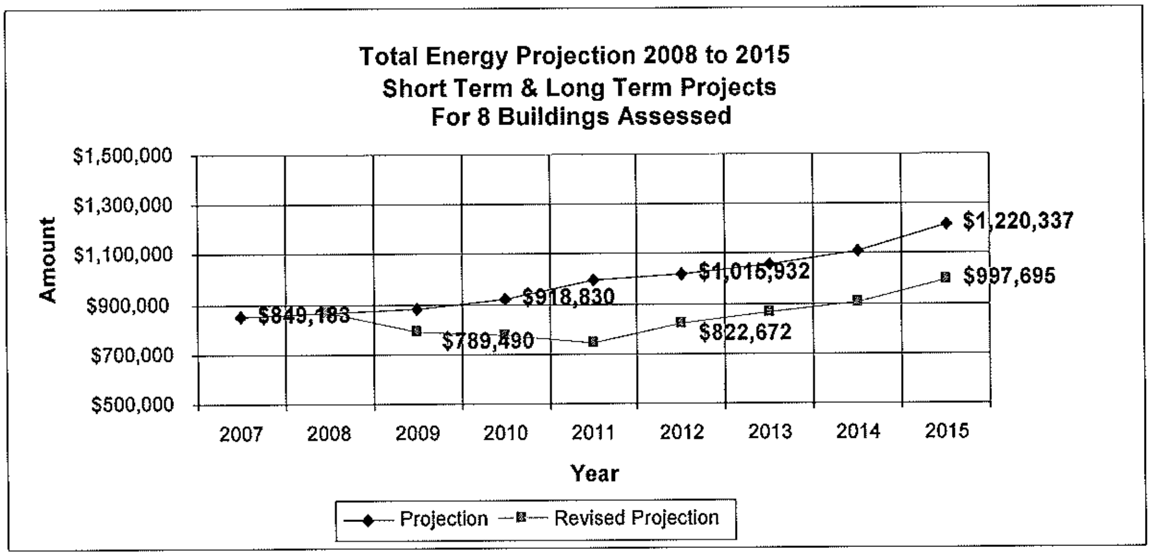
Long-Term Projects	Energy Costs after Short Term	Total Investment	Annual Savings	Payback Period (Years)
Citizen Services Center Proposed facility renovation is in the Capital Budget Plan within 5 years	$82,360	$385,800	**$34,100**	11.3
Courthouse Complex Proposed facility renovation is in the Capital Budget Plan within 5 years	$259,663	$430,000	**$53,000**	8.1
Public Works Office Bldg.	$25,112	No Long-term Projects Identified		
Health Department	$77,889	$30,000	**$6,000**	5.0
Law Enforcement	$188,344	0	**$30,000**	0.0
Urbana Library & Senior Center - Option B	$72,129	$10,000	**$3,100**	3.2
Transit Center	$35,386	No Long-term Projects Identified		

Westview Fire Station	$13,614	$1,600	**$200**	8.0
Totals	$754,497	**$857,400**	**$126,400**	**6.8**

The additional long-term investment is $857,400 and would result in an additional $126,400 saving per year

The payback period for the long-term projects would be 6.8 years

The following chart shows the revised energy cost projection upon implementation of both the short-term and long-term project recommendations, compared to projected energy costs:



Appendix B

Appendix B

Energy Management Program

Standard Building System Specifications and Operating Practices

The following are recommended Standard Building System Specifications and Operating Practices to guide in the implementation of the Energy Management Program.

Heating, Ventilation, and Cooling Systems

Standard Building System Specification

- Central plant systems are preferred when buildings are over 30,000 square feet.
- Multi-sectional cooling towers are preferred.
- Geothermal and variable refrigerant volume (VRV) technology is preferred where applicable.
- Variable air volume systems are preferred.
- Web-based digital Building Automation System control technology is required.
- Variable frequency drive technology should be used where applicable.
- Economizer control capability should be used where applicable.
- Soft start high efficiency motors should be used where applicable.
- Select equipment based on the available highest level energy efficiency or SEER ratings.

Operating Practices

- Inspect equipment routinely.
- Perform the winter and summer preventative maintenance tasks as recommended by the manufacturer.
- Replace filters quarterly unless environmental conditions warrant more frequent replacement cycles.
- Replace belts annually.
- Replace equipment that exceeds 15 years in installed operation with new units.
- Replace equipment that is over 10 years in installed operation with a new unit if the annual repair costs exceed one half of the replacement value.

Hot Water Boiler Systems

Standard Building System Specification

- Cast iron boilers are preferred.
- Consider the use of a series of smaller boiler units staged to meet demand.
- Web-based digital Building Automation System control technology is required.
- Install three way valves controlled by the Building Automation System were applicable.
- Soft start high efficiency motors should be used where applicable.
- Select equipment based on the available highest level energy efficiency or SEER ratings.
- Evaluate the daily consumption requirements and size new equipment to match the requirements.

Operating Practices

- Perform the daily and monthly preventative maintenance tasks as recommended by the manufacturer.
- Perform the winter and summer preventative maintenance tasks as recommended by the manufacturer.
- Set operating temperatures based on outside air temperatures and adjust to optimize efficiency.
- Control the hours of operation of large or oversized boiler systems during the non-occupied cycles.
- Replace equipment that exceeds 15 years in installed operation with new units.
- Replace equipment that is over 10 years in installed operation with a new unit if the annual repair costs exceed one half of the replacement value.

Building Automation System

Standard Building System Specification

- Install a computer based web-enabled central Building Automation System in all buildings to monitor and control individual area or room thermostats especially in the non-occupied periods of the work day.
- The Building Automation System shall be web-based and be capable of being monitored at the Central Maintenance Facility at 430 Pine Avenue, Frederick, Maryland.
- Individual room thermostat and sensor locations are preferred.
- Locate thermostats or sensors so that they are not affected by sunlight, drafts, vents and exterior temperatures.

- Thermostats or sensors should allow occupants two hour override capability in the non-occupied period of the work day. Units should reset to standardized program times daily.

Occupied Temperature Settings and Controls

Standard Building System Specification and Operating Practices

- The required building operating occupied temperature settings shall be 74 degrees when cooling and 68 degrees when heating.
- The Building Automation System shall monitor and send an alarm report when the individual temperature variances are greater than plus or minus two degrees.
- Monitor the temperature settings every month for all locations that are not controlled by a Building Automation System.
- Service thermostats, calibrate the time settings, and check temperature settings quarterly.

Non-occupied Cycle and Night Setback Temperature Settings and Controls

Standard Building System Specification and Operating Practices

- Establish a program to reduce energy use during the non-occupied periods of the work day and on weekends. Recommended non-occupied cycle times are thirty minutes after closing and one hour prior to opening.
- The recommended non-occupied and night set back building temperature is 78 degrees for cooling and 65 degrees for heating.
- The night setback building temperatures should not be greater than four degrees difference from the occupied temperature setting.
- The Building Automation System shall monitor and send an alarm report when the individual temperature variances are greater than plus or minus two degrees.
- Night setback temperature settings need to be controlled by the Building Automation System to insure that the energy needed to bring the building temperatures back to an occupied setting does not require more energy than was saved in the non-occupied cycle.

Special Use Heating, Ventilation, and Cooling Systems

Standard Building System Specification

- Special use areas that require cooling and heating temperatures at a fixed temperature for 24 hours a day should be separated from the rest of the building heating, ventilation and cooling systems to reduce the impact on the overall building energy consumption.
- Connect special use equipment controls to the Building Automation System were applicable.

- Select equipment based on the available highest level energy efficiency or SEER ratings.

Operating Practices

- Perform the daily and monthly preventative maintenance tasks as recommended by the manufacturer.
- Perform the winter and summer preventative maintenance tasks as recommended by the manufacturer.
- Replace equipment that exceeds 15 years in installed operation with new units.
- Replace equipment that is over 10 years in installed operation with a new unit if the annual repair costs exceed one half of the replacement value.

Lighting

Standard Building System Specification

- Install four tubes - four foot T-8 fixtures and 28 watt linear fluorescent bulbs with a standard reflector in offices and low ceiling areas.
- Install six tubes - four foot T-8 fixtures and 28 watt linear fluorescent bulbs with a silver type reflector in high ceiling areas.
- Consider replacing standard light fixtures used for “accent lighting” with fixtures that use LED bulbs or cold cathode bulbs.
- Do not use T-12, metal halide, sodium vapor, halogen, and mercury vapor fixtures and bulbs
- Replace existing T-12 fixtures and bulbs with T-8 fixtures and bulbs by 2010.
- Replace mercury vapor fixtures and bulbs with T-8 fixtures and bulbs.
- Replace fixtures that use metal halide bulbs with T-8 fixtures and bulbs.
- Replace halogen fixtures that use lamps in excess of 100 watts with new fixtures that use compact fluorescent bulbs.

Operating Practices

- Replace the current 32 watt linear fluorescent bulbs with 28 watt linear fluorescent bulbs as the current inventory of 32 watt bulbs is depleted.
- Use compact florescent bulbs to replace applicable incandescent bulbs.

Lighting - Foot-candle Levels

RECOMMENDED FOOTCANDLE (FC) LEVELS

Corridor and Stairways 10 -20 FC

- As low as 10 FC - for high reflectivity flooring/walls (white or pastel)
- Up to 20 FC for dark-colored flooring

Conference Rooms	30 FC at table height
Reception Areas	20 FC (avg. ambient) 50 FC (on task surface/desk)
Offices	55 FC (reading/ writing)
Conference rooms	55 FC (preferably natural lighting)
Computer rooms	15 FC
Restrooms	15 FC
General use areas	30 FC
Cafeteria (seating area)	30 FC
Cafeteria (food prep area)	75 FC

Exterior Lighting

Standard Building System Specification

- Use pulse start metal halide bulbs for parking lot and exterior lighting applications.
- Consider reducing the number of fixtures illuminated after 12 p.m. at night.
- Use lamp fixtures that are compatible with developing dark sky's regulations.
- Use seven day programmable time clocks in combination with a photocell to control exterior lights.

Operating Practices

- Replace 400 watt standard start bulbs with 320 watt pulse start bulbs as the current inventory of 400 watt bulbs is depleted.

Exit Fixtures

Standard Building System Specification

- Replace incandescent bulb type fixtures with units that use LED bulbs for new or replacement applications.

Lighting Controls

<u>Standard Building System Specification</u>

- Individual light control is preferred.
- Use occupancy sensors to control lights in storage rooms, mechanical rooms, pantries, copy rooms, and other support service areas using standard passive infrared sensor technology.
- Consider the use of occupancy sensors in offices using dual ultrasonic sensor technology.
- Consider the use of occupancy sensors in staff restrooms that are ceiling mounted using dual ultrasonic sensor technology.
- Consider computer based light controls that allow individual control flexibility, but can control lights in the non-occupied periods of the work day.
- Consider the addition of ambient light sensors to lighting circuits to control lights during the occupied periods of the work day when sunlight provides sufficient lights in lobbies, hallways, storage areas, and general work spaces.
- Control hallway lights in zoned areas.
- Provide the capability to custodians to override area hall light controls in the non-occupied periods of the work day.
- Connect lighting controls to the <u>Building Automation System</u> were applicable.

Domestic Hot Water Systems

<u>Standard Building System Specification</u>

- Consider the use of under sink insta-heat units where applicable.
- Consider the use of tankless hot water technology for low flow or intermittent demand requirements especially for restrooms, end of work day clean-up applications, and evening custodial applications.
- Use digital based controls with seven day programmable capability were applicable.
- Connection to the <u>Building Automation System</u> where applicable.
- Select equipment based on the available highest level energy efficiency or SEER ratings.
- Evaluate the daily consumption requirements. Match the size of the hot water heaters to meet the requirements.
- Separate standard domestic water use for restrooms, pantries, workrooms from kitchen and special use applications where applicable.

Operating Practices

- Inspect equipment routinely.
- Perform the monthly preventative maintenance tasks as recommended by the manufacturer.
- Set operating temperatures not to exceed 120 degrees.
- Control the hours of operation of large hot water tanks that exceed the hourly demand requirements by 50%.

Appliances

Standard Building System Specification

- Use the EPA Energy Star standards and ratings to guide in the purchase of appliances and equipment. Seek the mid level or higher rating for all purchases.
- Kitchen and special systems equipment should meet the standards set for the U.S. Department of Energy's Federal Energy Management Program.

Demand Monitoring and Reduction

Operating Practices

- Determine the facilities average annual demand reading and identify the month that the demand reading is the highest. Demand charges are based on kilowatt usage. Demand is read every 15 minutes.
- Facilities with demand readings over 400 kilowatts should be considered as candidates for demand reduction.
- Evaluate when and how equipment is operated.
- Establish a goal to reduce the demand kilowatt reading by 10% per month.
- Schedule the startup of heating, ventilation, and cooling equipment and lighting over three to four 15 minute periods in the morning.
- Reduce afternoon operating loads when temperatures exceed 95 degrees and humidity levels are over 60% through the Building Automation System control programs.

Air Compressors

Standard Building System Specification

- Install lead-lag controllers for applicable units.
- Install supplemental storage tanks if units operate on a continuous basis.
- Install time-clock or connect to the Building Automation System to turn units off in non-occupied periods.
- Size units properly for the load.
- Select equipment based on the available highest level energy efficiency or SEER ratings.

Operating Practices

- Inspect equipment routinely.
- Perform daily, monthly, and annual preventative maintenance tasks as recommended by the manufacturer.
- Turn off units at night.
- Evaluate unit operation with a focus on repairing leaks in lines and valves.
- Seek to replace systems that exceed 15 years in installed operation with new units.
- Replace equipment that exceeds 15 years in installed operation with new units.
- Replace equipment that is over 10 years in installed operation with a new unit if the annual repair costs exceed one half of the replacement value.

Water

Standard Building System Specification

- Install low-flow faucet aerators on sinks.
- Use automated controls on restroom sinks.
- Install low-flow automated controllers on urinals.
- Install dual flush manual valves to reduce consumption on toilets.
- Reduce exterior domestic water use for irrigation by 50%.
- Consider the use of rain water, surface water, or gray water for irrigation.

Unit Heaters

Standard Building System Specification

- Use programmable thermostats with seven day occupied and non-occupied cycle capability for individual heater locations.
- Select equipment based on the available highest level energy efficiency or SEER ratings.

Operating Practice

- Inspect equipment routinely.
- Set operating temperatures for 65 degrees during occupied cycles and 55 degrees in non-occupied cycles in the winter.
- Turn units off in the summer.

Exhaust Systems

Standard Building System Specification

- Install seven day time clocks to control exhaust systems to turn off fans in the non-occupied periods of the work day.
- Consider the connection of the exhaust fan controls with the light switch controls in restrooms, were applicable codes will permit turning off fans.

- Consider the use of occupancy sensors to control the operation of exhaust systems, were applicable codes will permit turning off fans.
- Large systems should be connected to the Building Automation System.

Operating Practices
- Inspect equipment routinely.
- Perform annual preventative maintenance tasks as recommended by the manufacturer.

Building Envelope

Standard Building System Specification
- The envelope specifications will adhere to the prescriptive standards listed in ASHRAE 90.1-1999.
- Use a computer simulation under the Energy Cost Budget section of ASHRAE 90.1-1999 to achieve the optimum rating.

Roofing

Standard Building System Specification
- Adopt the application of low heat island effect roof or Thermoplastic Polyolefin (TPO) roofs material as the standard when installing a new roof or roof replacement starting in 2010.
- Roofing products shall comply with the technical specifications of the U.S. EPA's Energy Star labeled roof products for new construction.

Windows

Standard Building System Specification
- Windows will comply with the technical specifications for new construction.

Appendix C

Appendix C

Portfolio Manager Ratings for Frederick County Buildings

Ln	Facility Name	2007 Rating (1-100)	2009 Rating (1-100)
1	30 N Market St	59	57
2	Adult Detention Center	42	39
3	Animal Control	8	9
4	Citizens Services	1	1
5	Courthouse Complex	69	73
6	Department of Public Works	65	70
7	Emergency Services Building	45	41
8	Emmitsburg Community Center	48	46
9	Extension Service	37	28
10	FCBEC (One Stop)	62	76
11	Head Start	25	25
12	Health Department	73	77
13	Highway Department	43	41
14	IIT Building	54	53
15	Law Enforcement Center	29	39
16	Maintenance Shop	53	49
17	Public Safety Training	30	46
18	Senior Center	58	71
19	Winchester Hall	29	37
20	Work Release	28	27

NOTE: Portfolio Manager rankings are expressed as the percentile ranking of a building's energy efficiency when compared to energy efficiencies of other buildings of a similar size and use, and taking into account regional and seasonal variations in the weather. A ranking of 75 would indicate that 75% of similar buildings are less energy efficient.

Appendix D

Appendix D
FREDERICK COUNTY BUILDINGS HVAC-RELATED RENOVATIONS

		COMPLETION	HVAC MECHANICAL	HVAC DUCTWORK	HVAC CONTROLS	FIRE ALARM	SPRINKLER SYSTEM	HAZMAT ABATEMENT	FLOORPLAN CHANGES	CARPET REPLACEMENT	PAINT	NEW CEILING AND TILE	ADA UPGRADES	ROOF REPLACEMENT		Total Project Cost	Square Footage	Cost per Square Foot
1	FREDERICK SENIOR CENTER	10/03	P	P	P	X	X		X	X	X	X	X	P	Major building renovation	$747,000	16,900	$44
2	EMMITSBURG COMMUNITY CENTER	02/04	X	X	X	X	X	X	X	X	X	X	X	X	Major building renovation	$4,600,000	33,000	$139
3	HIGHWAY/FLEET	02/05	X	X	X	X					X	X		X	HVAC at end of useful life	$480,000	15,300	$31
4	HEAD START BUILDING	09/05	X	X	X	X	P	X	X	X	X	X			Major building renovation	$873,000	10,000	$87
5	DPW BUILDING	03/07	X	X	X	X	X	X	X	X	X	X	X		Major building renovation	$2,105,543	24,500	$86
6	WINCHESTER HALL E. WING & ANNEX	07/08	X	X	X	P		X	X	X	X	X			HVAC at end of useful life	$3,045,316	48,000	$63
7	POINT OF ROCKS RURITAN CLUB	09/08	X	X	X	X						X			HVAC at end of useful life	$449,061	4,500	$100
8	SCOTT KEY CENTER (+ ADDITION)	12/09	X	X	X							X			HVAC at end of useful life			
9	ANIMAL CONTROL	FY10	X	P	X	X	X	X		X	X				HVAC at end of useful life and humidity control issues	$1,589,000	11,700	$136
10	EXTENSION SERVICE	FY11	X	X	X	X		X			X	X			HVAC nearing end of useful life; humidity control issues	$1,256,000	14,000	$90
11	COURTHOUSE	FY12	P		P										HVAC units+controls at end of useful life	$567,000	100,000	$6
12	FREDERICK SENIOR CENTER	FY12	P	P	P										Replace HVAC components not replaced in 03 renovation	$450,000	16,900	$27
13	IIT BUILDING	FY13	X	X	X	X		X		X	X	X	X		HVAC nearing end of useful life	$1,271,000	9,300	$137
14	300 SCHOLLS LANE	FY13	X	X	X	X		X	X	X	X	X	X		Gut and rehab Elections; HVAC upgrade Substance Abuse	$2,131,000	18,000	$118
15	520 N. MARKET STREET	FY14	X	X	X	X		X	X	X	X	X	X		HVAC nearing end of useful life/ operating costs high to control humidity	$2,716,000	25,742	$106
16	ADULT DETENTION	FY14	P		P										HVAC units+controls at end of useful life	$542,000	110,000	$5
																$22,821,920	457,842	$52

P = PARTIAL REPLACEMENT/PARTIAL UPGRADE

Prepared by: Management Services Division
Date: February 27, 2007
Updated: 01/12/2010 JS

Appendix E

Technology Energy Management Plan
Frederick County Interagency Information Technologies (IIT)
April 14, 2008

Technology Strategic Goal #6: Technology Infrastructure

1. By April 2008, develop an Energy Management Plan for Technology that establishes a baseline of the County's technology energy demands ensures adequate power to meet future needs and outlines initiatives to support the County's comprehensive energy plan.

Desktops - Laptops - Smart Clients (VDI)

Objective

Reduce power consumption by implementing Smart Client desktop technology for low to mid use clients. Take advantage of power saving features for desktops and laptops. Long term objective will be to phase out the desktop for low to mid-level users in favor of thin clients and/or software as a service.

Low-use client: An employee who requires minimal connectivity to perform such tasks as filling out time sheets or minimal Internet usage

Mid-use client: An employee who uses basic office applications such as word processing, spreadsheets, e-mail and a browser

High-end user: An employee who uses resource intensive applications including, but not limited to Geographic Information Systems (GIS), development tools, ERP processing and advanced office tools.

1. Smart Clients (VDI - Virtual Desktop Infrastructure)

- Requirements:
  - SAN storage space
  - VMWare Virtual Desktop
  - Smart Client / Thin Client
- Benefits

  - Power Savings due to no local hard drives, no external hardware ports (e.g. USB), no floppy drives.

Accomplishment:

Smart Clients (VDI - Virtual Desktop Infrastructure)

- By June 30, 2008, IIT will be testing Thin Client / Smart Client on the network
- Adequate SAN storage exists for VDI testing with the purchase of the new storage modules
- Establish a test Virtual Desktop by fall 2008 working with consultant from Niksar Data Management

2. Green Desktops

- Modify desktop settings to enable all green mode functions
- Develop policy and enable sleep mode
- Review savings - green PC vs a non green PC – are there actual gains?

Accomplishments:

Green Desktops

- Additional research in progress through FY08
- Investigating impact and savings of remote PC shutdown after hours

Servers

Objective

Reduce server power consumption through the use of energy smart (green) servers and server virtualization.

1. Green Servers
   - Purposed when an application needs its own server
   - Purposed when application will not run in a VMWare environment

Accomplishment:

Green Servers

- Have purchased and ready to go into service

2. Power Servers – utilizing VMWare ESX Operating System
   - High horsepower servers, maximized memory, CPU and disk space
   - Used for ESX VMWare
   - Goal is to obsolete 6 to 10 physical servers per ESX server

Accomplishment:

Power Servers – utilizing VMWare ESX Operating System

- We now have 34 virtual servers running under 5 ESX physical servers
  The 5 ESX servers use a total wattage of 3,750 watts at peak use.

If we were to run the 34 virtual servers on actual hardware we would be using 24,140 watts at peak use.

24,140 watts
-3,750 watts
20,390 watts – wattage we are "saving"

20k x 365 x 24 = 175200KW
Price per KWK = .08723 – this number can fluctuate come because of the power company charges for demands
175200KW * .08723 = $15,282.69 savings per year

IP SAN

Objective

Use our IP SAN technology coupled with Smart Clients to reduce power consumption throughout the county. The use of Smart Clients eliminates the personal PC hard drive.

Accomplishment:

1. Preparing to test Virtual Desktop on IP SAN to understand potential savings.

Printers

Objective

Reduce energy usage by using Savin printers in place of multiple personal and network printers within the county.

1. Local Printers
    - Minimize local printers – standard for getting a local printer, not within walking distance of a network printer or a multifunction printer.
    - Research green printer models – all-in-one printers

Accomplishment:

Local Printers

- Replacing local printers with multi-function printers – ongoing process
- Research Green Printer Models – on-going research and evaluation

2. Network Printers
    - When printing volume does not justify a large workgroup multifunction
    - Research green printer models – all-in-one printers

Accomplishment:

Network Printers

- Research Green Printer Models – on-going research and evaluation

3. Multi-function Printers
    - Standard shared workgroup models to replace all printers where possible

Accomplishment:

Multi-function Savin Printers

- Accomplished – Review impact of cost savings and will standardize on two color models when contract is renewed in 5 years

Data Center

Objective
Reduce overall energy usage in the Data Center while providing the same level of service our customers have come to expect.

1. Lighting
    - Install motion sensor switches in the Data Center.

Accomplishment:

Lighting

- Work order submitted.

2. Air Conditioning
    - Rearrange server racks to maximize data center cooling.
    - Install Inline Rack air conditioning.

Accomplishment:

Air Conditioning

- In process of rearranging the server racks to improve air flow within the Data Center.
- Retiring servers to decrease the heat flow and energy consumption in the Data Center.
- Working with APC on Inline Rack air conditioning design. Requested funding via a Data Center Capital Improvement Project.

3. Power Management
    - Measure ongoing power usage for the entire data center at Winchester Hall.

Accomplishment:

- Submitted work order for permanent placement of power measuring equipment at Winchester Hall

Appendix F

Appendix F

Building Commissioning/Energy Performance Contracting

Annual General Administration Training and Trade Show

November 14, 2003

Roger Wigfield, P.E.

What is building commissioning?

Building Commissioning is - a systematic and documented process of ensuring that the owner's operational needs are met, building systems perform efficiently, and building operators are properly trained.

Types of building commissioning

- **New Building Commissioning:** is used on new building or major renovations of existing buildings.
- **Re-Commissioning:** is used on buildings that have been previously commissioned.
- **Retro-Commissioning:** is performed on buildings that have never been commissioned.

What is new building commissioning?

- **New building commissioning** – ideally starts in the pre-design or design phase of a project and goes through construction.

  The focus is typically on the heating ventilating and air conditioning. Other systems to consider include the building envelope, emergency power, and any other system that has been a problem for the building owner on previous construction projects.

What is re-commissioning?

- **Re-commissioning is -** to commission a building that has been commissioned before. This commissioning is done to ensure that the building is operating optimally and all systems are functioning as intended.
- Studies have suggested that buildings should be re-commissioned every three to five years.

What is retro-commissioning?

Retro-Commissioning is -

- Assurance that the building operates to original design intent.
- A systematic process for improving and optimizing a building's operations and maintenance.
- Usually focused on energy-using equipment such as mechanical equipment, related controls, and lighting.

What is the goal of retro-commissioning?

- To identify and fix existing problems, such as indoor air quality and to improve the energy efficiency of the building.
- To provide a facility that meets the current needs of the building owner and occupants.
- To provide training for facility operators on the operation and maintenance of the existing building systems.

What does retro-commissioning involve?

- Verifying and documenting existing building systems' performance.
- Testing HVAC systems' performance to ensure that they meet the current needs.
- Identifying and recommending solutions to existing building problems.

When to retro-commission

- If the building has never been commissioned.
- If the original usage of the building has changed.
- If the building is experiencing:
  - occupant comfort complaints.
  - indoor air quality problems.
  - higher energy costs.
  - numerous operation and maintenance problems.

Developing the retro-commissioning scope of work

- Before meeting with the commissioning agent develop a draft retro-commissioning scope of work.
- Ask the facility owner and operator what problems they are encountering.
- Interview building staff to find out what problems they are experiencing.

What should be budgeted for retro-commissioning?

- $0.40 to $1.20 per square foot depending on the complexity, size and location of the building.
- General housekeeping done before commissioning is started can help reduce costs.
- Assigning maintenance staff to assist the commissioning agent can also help reduce the cost and it provides a good training opportunity.

Cost savings for retro-commissioning

- 5% - 20% reduction in operating costs for a building that is retro-commissioned.
- 1.5 – 7.5 year simple payback on retro-commissioning projects is typical.

  This is based on:
  - lower energy usage.
  - reduced operational problems.
  - improved occupant comfort.

General Administration's Commissioning Program

- Provides assistance and guidance throughout the commissioning process.
- Provides direct access to qualified commissioning agents.
- You select the most qualified commissioning agent for your project.

General Administration's Commissioning Program

- Helps negotiate the scope of work and commissioning cost.
- Writes and manages the contract with the commissioning agent for you.

Retro-commissioning projects

- Bellingham Technical College, Administration Building (indoor air quality)
- Riverside School District, Riverside High School (indoor air quality)
- North Thurston School District, North Thurston High School (energy usage and indoor air quality)

Retro-commissioning projects

- Clover Park School District, Park Lodge Elementary (occupant comfort)
- Clover Park School District, Idlewild and Oakbrook Elementary Schools (energy usage)
- Yelm School District, Prairie Elementary (occupant comfort and energy usage)

Retro-commissioning projects

- North Mason School District, Sand Hill Elementary (energy savings and occupant comfort)
- Department of Ecology, Headquarters Building Olympia (indoor air quality)
- Capital Campus, Office Building 2 (occupant comfort and energy usage)

Building commissioning resources

- GA's Building Commissioning Program: www.ga.wa.gov/eas/bcx
- Building Commissioning Association: www.bcxa.org

Thank You

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Appendix G

Appendix G

Frederick County
Maryland

Transportation Fleet

Energy Utilization & Mileage Efficiency Plan

Submitted by:

CQI Associates

April 30, 2009

(Last Revisions: 7/30/2009)

Frederick County

Transportation Fleet Energy Utilization & Mileage Efficiency Plan

2009 to 2024

Objective

The objective of this study is to evaluate the existing Frederick County transportation fleet and to develop a set of recommended improvements, projects, and programs resulting in a reduction of non-renewable sources of energy by 2022. The study also evaluated technology improvements that will improve mileage efficiency and reduce energy consumption.

Approach

The Frederick County transportation fleet was divided into five groups:

- **General Fleet Vehicles** - Sedans, Standard Utility Vehicles, Vans - Appendix Table 1
- **Public Safety Vehicles** - Sheriff Department and Fire & Rescue Department Fleet Vehicles - Sedans, Standard Utility Vehicles, and Trucks - Appendix Table 2
- **Truck Vehicles** - Pickup Trucks, Dump Trucks, Licensed Construction Vehicles - Appendix Table 3
- **Public Transit Large Buses** - 29 to 30 Passenger Transit Buses - Appendix Table 4
- **Small Passenger Buses** - 11 to 23 Passenger Buses - Appendix Table 5

The Water and Sewage Administration General Fleet and Truck Vehicles are included in this assessment.

Fire trucks and ambulances were not included since fuel economy specifications are not available. Off-road or non-licensed vehicles and equipment were not included for the same reason.

CQI Associates has conducted research on methods, strategies and technologies that are involved in the improvement of the vehicle fleet fuel utilization and mileage efficiency.

This study evaluated the fuel utilization and mileage efficiency for the current fleet of vehicles. CQI Associates used the fuel economy specifications in www.fueleconomy.gov to develop the assessments included in this study.

For the Comparable 2008 Vehicle Assessments, CQI Associates used data for 2008 vehicles that most closely matched the existing vehicle lists, Appendix Tables 1 to 5, trying to match manufacturer, make, and model where possible.

The U.S. Environmental Protection Agency 2008 miles per gallon rating data (mpg) has been modified by using more representative driving conditions, thus the mpg numbers are lower than previous years. The new testing process has significantly reduced the estimated fuel economy – in some cases up to 25 percent. The revised testing procedures more accurately reflect today's traffic conditions, driving habits, and vehicle usage.

City ratings dropped by an average of 12 percent. Highway ratings dropped by an average of 8 percent. The fuel economy estimates of hybrid vehicles and other vehicles designed for high fuel economy dropped 25 percent.

CQI completed the following assessments for the five vehicle groups:

- Evaluated the list of existing vehicles (as provided) in the fleet. (Current Vehicles)

- Evaluated the upgrade of each vehicle in the current fleet using the current comparable 2008 vehicle. (Comp 2008 Vehicles)

- Evaluated the upgrade of the existing vehicles with the best-in-class gasoline or diesel fuel economy leader. (Best Gas or Best Gas & Diesel)

- Evaluated the upgrade of the existing vehicles with the best-in-class bio diesel fuel economy leader. (Best Bio Diesel)

- Evaluated the upgrade of the existing vehicles with the best-in-class hybrid gasoline fuel economy leader. (Best Gas with Hybrid)

- Evaluated the upgrade of the existing vehicles with the best-in-class ethanol fuel economy leader. (Best Gas with Ethanol)

- Combined the results of the other assessments using the best-in-class gasoline vehicles, hybrid vehicles, and the use of bio diesel fuel for the existing diesel trucks. (Best Gas with Bio Diesel with Hybrid)

CURRENT FLEET ASSESSMENT

CQI Associates' first task was to evaluate the list of current vehicles in the fleet, Appendix Tables 1 to 5, provided by the County.

CQI Associates used the fuel economy specifications in www.fueleconomy.gov to develop an assessment of the County's existing fleet as follows:

General Fleet Vehicles		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles	774,772	16.4

Public Safety Vehicles		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles	3,201,941	14.6

Truck Vehicles		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles Gas & Diesel	2,124,128	9.8

Public Transit Large Buses		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles Diesel	566,899	3.8

Small Passenger Buses		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles Gas & Diesel	865,260	8.7

Total Miles 7,533,000

VEHICLE ASSESSMENT RESULTS BY GROUP

CQI Associates' second task was to evaluate the list of current vehicles in the fleet with proposed options to improve fuel efficiency measured in miles per gallon.

The following are the results of the assessment for the five vehicle groups evaluated in this study.

General Fleet Vehicles

The General Vehicles include all vehicles not included in the other groups. These are licensed vehicles for on-road use. Construction equipment and related equipment are not included if the vehicle is not licensed.

General Fleet Vehicles		
Analysis	Total Miles	Average MPG
Current Vehicles	774,772	16.4
Comp 2008 Vehicles	774,772	19.1
Best Gas	774,772	21.5
Best Gas with Hybrid	774,772	26.3
Best Gas with Ethanol	774,772	18.3

Public Safety Vehicles

The Public Safety Vehicles include full-size cruisers, four-wheel drive, SUV's and special use vehicles. All general Public Safety fleet vehicles assigned to the Sheriff Department and Fire & Rescue Department are included in this assessment. Vehicles assigned to volunteer Fire & Rescue Department organizations are included. Fire trucks and ambulances were not included since fuel economy specifications are not available.

For the best gas analysis, two options were analyzed. The first using the Crown Victoria for the full size cruiser and the second using the Dodge Charger for the full size cruiser. The Dodge Charger yields better mpg than the Crown Victoria.

Public Safety Vehicles		
Analysis	Total Miles	Average MPG
Current Vehicles	3,201,941	14.6
Comp 2008 Vehicles	3,201,941	19.3
Best Gas with Dodge Charger	3,201,941	21.6
Best Gas with Crown Victoria	3,201,941	19.4
Best Gas with Hybrid	3,201,941	25.2
Best Gas with Ethanol	3,201,941	15.7

Truck Vehicles

The truck vehicle assessment was conducted to include small trucks, large trucks (1-ton through 10-ton dump trucks) and licensed construction vehicles.

CQI Associates has included a recommendation to migrate the diesel trucks to B20 bio diesel to improve fuel utilization and mileage efficiency. The Consumer Energy Council of America has documented that a blend of 20% bio diesel can reduce emissions by 15% over petroleum diesel.

The best gas, hybrid, and bio diesel option includes the 2009 Hybrid Silverado for the Full Size Pickup class.

Truck Vehicles		
Analysis	Total Miles	Average MPG
Current Vehicles Gas & Diesel	2,124,128	9.8
Comp 2008 Vehicles Gas & Diesel	2,124,128	14.7
Best Gas & Diesel	2,124,128	16.0
Best Gas & Bio diesel (Note 1)	2,124,128	16.0
Best Gas, Hybrid, and Bio diesel	2,124,128	16.2

Note 1: Emissions reduction 15% with Bio diesel

Public Transit Large Buses and Smaller Passenger Buses

CQI Associates separated the assessment of Public Transit vehicles into two groups: Public Transit Large Buses and Small Passenger Buses.

For vehicles using hybrid technology, CQI Associates assumed a 35% improvement in MPG over diesel, and a 30% reduction in emissions. These estimates are based on a New York City Transit Authority specification for the Orion Hybrid buses.

New York City Transit Authority conducted a 12 month study comparing hybrid, compressed natural gas (CNG), and diesel bus technology.

The final report is *Technical Report* NREL/TP-540-40125 refer to http://www.nrel.gov/vehiclesandfuels/fleettest/pdfs/40125.pdf

For vehicles using CNG technology, CQI Associates assumed a 25% worse MPG factor in moving from diesel to CNG based on the New York City Transit results.

Public Transit Large Buses		
Analysis	Total Miles	Average MPG
Current Vehicles Diesel	566,899	3.8
Bus with Bio diesel (Note 1)	566,899	3.8
Bus with Bio diesel and CNG	566,899	2.6
Bus with Bio diesel and Hybrid	566,899	5.1

Note 1: Emissions reduction 30% with Bio diesel

Small Passenger Buses		
Analysis	Total Miles	Average MPG
Current Vehicles Gas & Diesel	865,260	8.7
Comp 2008 Vehicles Gas & Diesel	865,260	9.5
Best Gas & Diesel	865,260	9.5
Best Gas & Bio diesel (Note 1)	865,260	9.5

Note 1: Emissions reduction 30% with Bio diesel

Hybrid Buses

The 40-foot low-floor, Orion VII hybrid buses offer a HybriDrive™ diesel-electric propulsion system by BAE Systems propelling the bus with a single electric motor that is powered by a diesel-driven generator and an energy storage unit. The Orion hybrid is equipped with a smaller, cleaner burning diesel engine with quicker acceleration than conventional diesel-only buses. The Orion hybrid uses a 5.9-liter, 260 hp (194 kW) Cummins ULSD (Ultra Low-Sulfur Diesel) engine with a 120 kW traction generator. The high-torque traction motor delivers 250 hp (186 kW) and 2,700 lb-ft (3,657 Nm) of low-end torque yielding more than enough power for typical usage.

The Orion hybrid bus has no transmission and uses regenerative braking to charge the batteries, this results in a quieter ride and lower maintenance costs on the whole (including the reduction of brake replacement) by approximately one-third. Alternative drive systems from Daimler Trucks and Daimler Buses are now to be made available to customers in other product segments and regions. Freightliner in North America will soon produce 1500 M2 hybrid trucks, as well as hybrid versions of the legendary school buses from Thomas Built Buses. The Orion VII hybrid buses have improved fuel economy to more than 30% compared to conventionally powered buses. In addition, the Orion hybrids significantly reduce emissions with 90% less particulate matter, 40% fewer oxides of nitrogen, and 30% fewer greenhouse gases.

Based on the New York City Transit Authority study the hybrid bus achieved 37% higher fuel economy. The hybrid bus also exhibited 88% higher fuel economy than the Compressed Natural Gas bus.

The New York City Transit Authority estimated purchase price of hybrid buses was $500,000 each, which is reportedly about $150,000 more than a new standard clean diesel bus.

FUEL OPTIONS

Gasoline

Since the majority of the non-maintenance vehicles are fueled with gasoline and since it will take 8 to 10 years to convert all the vehicles to another fuel source it was determined that the fleet would need to continue to be fueled with gasoline. The current gasoline fuel contains 10% ethanol mix and is included in the baseline data.

Bio Diesel

Bio diesel has significant environmental benefits over petroleum diesel. B20 bio diesel is recommended and is a blend of 20 percent bio diesel with 80 percent petroleum fuel. Use of B20 most often has no effect on the overall fuel economy as compared to diesel.

Engine manufactures have not stated formally that the use of blends up to B20 will void their parts and workmanship warranties. This issue is still a concern. As an example, Cummins has specifications and notes on its website as to the use of B20 bio diesel with its engines. It specifies which engines can be used with bio diesel fuels. It specifies the filters that must be used, the maintenance that must be followed, fuel storage guidelines as well as other pertinent information. It does not approve of use of bio diesel with engines made prior to 2002.

The Maryland State Highway Administration (MSHA) operates 90% of their diesel vehicles on B20 in the warm months and B5 in the cold months. Montgomery County Public School District is upgrading their diesel fueling station to bio diesel to fuel the buses. Safeway uses bio diesel throughout its fleet of more than 1,000 trucks.

E-85 Ethanol

An analysis was conducted reviewing the best ethanol vehicle in a given class of vehicles. In general, ethanol vehicles have lower miles per gallon ratings and have a slightly lower carbon dioxide output per year (tons/year) than traditional gasoline fueled vehicles.

To convert to E-85 ethanol fuel over the next eight years the process would require the purchase of new vehicles and the installation of additional fueling stations. Since the capital cost would be significant and the improvements in mileage efficiency are negligible, this fuel conversion is not considered cost effective as of 2008. This option should be evaluated again in 2012.

VEHICLE REPLACEMENT RECOMENDATIONS

The third task was to identify a preferred list of vehicles for each of the five groups evaluated that improved mileage efficiency, reduced emissions, and used renewable energy.

The vehicles proposed are based on the vehicles available in the 2008 model year. County Staff will need to make an evaluation each model year to determine the **Best-in-Class** vehicles based on actual mileage data and fuel economy specifications in www.fueleconomy.gov.

Stepping up the replacement cycles of the current fleet will improve fuel utilization and mileage efficiency since newer vehicles will be manufactured to meet new mileage efficiency standards. Since there is less alternative technology for heavy-duty vehicles, increasing the frequency of truck vehicle replacement is important to improve fuel utilization and mileage efficiency.

Based on this study the recommended 2008 vehicles that will improve fuel utilization and mileage efficiency of the current fleet are:

CLASS	CLASS DEFINITION	BEST GAS & Diesel 2008 REPLACEMENT Option 1	MILEAGE
C001H	SEDAN COMPACT 2WD HYBRID	HONDA CIVIC HYBRID	40/45/42
C001U	SEDAN COMPACT 2WD	TOYOTA COROLLA	26/35/29
C002U	SEDAN MIDSIZE 2WD	DODGE CHARGER	18/26/21
C003U	CRUISER MIDSIZE 2WD UNMARKED	DODGE CHARGER	18/26/21
C004U	CRUISER MIDSIZE 2WD	DODGE CHARGER	18/26/21
C005U	SEDAN FULLSIZE 2WD	DODGE CHARGER	18/26/21
C006U	CRUISER FULLSIZE 2WD UNMARKED	DODGE CHARGER	18/26/21
C007U	CRUISER FULLSIZE 2WD MARKED	DODGE CHARGER	18/26/21
S001H	SUV COMPACT 4WD HYBRID	Ford Escape Hybrid	34/30/32
S001U	SUV COMPACT 4WD	JEEP COMPASS 4WD	21/24/22
S003U	SUV MIDSIZE 4WD	MITSUBISHI OUTLANDER	20/25/22
S005U	SUV FULLSIZE 4WD UNMARKED	GMC YUKON 1500	14/19/16
S006U	SUV FULLSIZE 4WD	GMC YUKON 1500	14/19/16
S007U	SUV FULLSIZE XTRA 4WD	GMC YUKON 1500	14/19/16
T001U	PICKUP 2WD 1/2 TON	TOYOTA TACOMA 2WD	19/25/21
T004U	PICKUP 4WD 1/2 TON	CHEVY COLORADO 4WD	17/22/19
T007U	PICKUP 2WD 3/4 TON	CHEVY SILVERADO C15	15/20/17
T010U	PICKUP 4WD 3/4 TON	HONDA RIDGELINE	15/20/17
V001U	VAN 5PASS 2WD	MAZDA 5	21/27/23
V002U	VAN 7PASS 2WD	HONDA ODYSSEY	17/25/20

V003U	VAN 8PASS 4WD	CHEVY EXPRESS1500 AWD	12/16/14
V004U	VAN 12 PASS 2WD	CHEVY EXPRESS 2WD	12/16/14
V005U	VAN 15 PASS 2WD	CHEVY EXPRESS 2WD	12/16/14
V008U	CARGO VAN 1/2 TON 2WD	CHEVY EXPRESS 1500/2500	15/20/17
V009U	CARGO VAN 3/4 TON 2WD	CHEVY EXPRESS 1500/2500	14/18/16
V010U	CARGO VAN 1 TON 2WD	CHEVY EXPRESS 1500/2500	14/18/16

CLASS	**CLASS DEFINITION**	**BEST GAS 2008 REPLACMENT Option 2**
C001H	SEDAN COMPACT 2WD HYBRID	Same
C001U	SEDAN COMPACT 2WD	FORD FOCUS
C002U	SEDAN MIDSIZE 2WD	NISSAN ALTIMA, DODGE CALIBER
C003U	CRUISER MIDSIZE 2WD UNMARKED	NISSAN ALTIMA, DODGE CALIBER
C004U	CRUISER MIDSIZE 2WD	NISSAN ALTIMA, DODGE CALIBER
C005U	SEDAN FULLSIZE 2WD	Crown Vic 15/23/18 10.2
C006U	CRUISER FULLSIZE 2WD UNMARKED	Crown Vic 15/23/18 10.2
C007U	CRUISER FULLSIZE 2WD MARKED	Crown Vic 15/23/18 10.2
S001H	SUV COMPACT 4WD HYBRID	Same
S001U	SUV COMPACT 4WD	JEEP PATRIOT,HONDA CRV
S003U	SUV MIDSIZE 4WD	CHEVY SUBURBAN
S005U	SUV FULLSIZE 4WD UNMARKED	CHEVY SUBURBAN
S006U	SUV FULLSIZE 4WD	CHEVY SUBURBAN
S007U	SUV FULLSIZE XTRA 4WD	CHEVY SUBURBAN
T001U	PICKUP 2WD 1/2 TON	FORD RANGER
T004U	PICKUP 4WD 1/2 TON	GMC CANYON,TOYOTA TACOMA 4WD
T007U	PICKUP 2WD 3/4 TON	DODGE DAKOTA,GMC SIERRA
T010U	PICKUP 4WD 3/4 TON	DODGE DAKOTA 4WD,CHEVY SILVERADO K15
V001U	VAN 5PASS 2WD	Same
V002U	VAN 7PASS 2WD	CHYRSLER T&C,DODGE CARAVAN
V003U	VAN 8PASS 4WD	GMC SAVANNA
V004U	VAN 12 PASS 2WD	GMC SAVANNA
V005U	VAN 15 PASS 2WD	GMC SAVANNA
V008U	CARGO VAN 1/2 TON 2WD	GMC SAVANNA
V009U	CARGO VAN 3/4 TON 2WD	GMC SAVANNA

V010U	CARGO VAN 1 TON 2WD	GMC SAVANNA
TRUCK	3/4+ Ton Trucks	Bio diesel for Diesel Trucks

CLASS	CLASS DEFINITION	BEST GAS, Bio Diesel & HYBRID 2008 REPLACEMENT	MILEAGE
C001H	SEDAN COMPACT 2WD HYBRID	HONDA CIVIC HYBRID	40/45/42
C001U	SEDAN COMPACT 2WD	HONDA CIVIC HYBRID	40/45/42
C002U	SEDAN MIDSIZE 2WD	TOYOTA PRIUS	48/45/46
C003U	CRUISER MIDSIZE 2WD UNMARKED	TOYOTA PRIUS	48/45/46
C004U	CRUISER MIDSIZE 2WD	TOYOTA PRIUS	48/45/46
C005U	SEDAN FULLSIZE 2WD	CHEVY IMPALA	18/29/22
C006U	CRUISER FULLSIZE 2WD UNMARKED	CHEVY IMPALA	18/29/22
C007U	CRUISER FULLSIZE 2WD MARKED	CHEVY IMPALA	18/29/22
S001H	SUV COMPACT 4WD HYBRID	Ford Escape Hybrid	34/30/32
S001U	SUV COMPACT 4WD	Ford Escape Hybrid	34/30/32
S003U	SUV MIDSIZE 4WD	TOYOTA HIGHLANDER	27/25/26
S005U	SUV FULLSIZE 4WD UNMARKED	GMCYUKONHYBRID	20/20/20
S006U	SUV FULLSIZE 4WD	GMCYUKONHYBRID	20/20/20
S007U	SUV FULLSIZE XTRA 4WD	GMCYUKONHYBRID	20/20/20
T001U	PICKUP 2WD 1/2 TON	TOYOTA TACOMA 2WD	19/25/21
T004U	PICKUP 4WD 1/2 TON	CHEVY COLORADO 4WD	17/22/19
T007U	PICKUP 2WD 3/4 TON	09 CHEVY SILVERADO HYBRID	19/23/21
T010U	PICKUP 4WD 3/4 TON	09 CHEVY SILVERADO HYBRID	19/23/21
V001U	VAN 5PASS 2WD	MAZDA 5	21/27/23
V002U	VAN 7PASS 2WD	HONDA ODYSSEY	17/25/20
V003U	VAN 8PASS 4WD	CHEVY EXPRESS1500 AWD	12/16/14
V004U	VAN 12 PASS 2WD	CHEVY EXPRESS 2WD	12/16/14
V005U	VAN 15 PASS 2WD	CHEVY EXPRESS 2WD	12/16/14
V008U	CARGO VAN 1/2 TON 2WD	CHEVY EXPRESS 1500/2500	15/20/17
V009U	CARGO VAN 3/4 TON 2WD	CHEVY EXPRESS 1500/2500	14/18/16
V010U	CARGO VAN 1 TON 2WD	CHEVY EXPRESS 1500/2500	14/18/16
TRUCK	3/4+ Ton Trucks	Bio diesel for Diesel Trucks	11/17/14
BUS	Buses	Orion Hybrid Bus	9/7/5

VEHICLE MAINTENANCE & OPERATION IMPROVEMENT RECOMMENDATIONS

The following technologies have been verified by U.S. Environmental Protection Agency (EPA) to reduce emissions from diesel powered vehicles and engines, and as a result are eligible for funding under the National Clean Diesel Campaign.

Reduction of Idle Time

Elimination of unnecessary idling can save fuel, extend engine life and reduce emissions. For most on-road, heavy-duty fleets, idling can account for more than 50 percent of total trip time. The amount of diesel fuel burned, the emissions produced, and the maintenance impacts to truck owners are significant.

Caterpillar, Inc. offers an "idle shutdown timer" on its electronic engines to help drivers remember not to idle for too long. It can be programmed to turn off the engine after up to 60 minutes of idling.

Idle reduction technologies cited by the SmartWay Technology Partnership (from their June 15 *"The Smart Way to Green Your Fleet and Save Money"* by the Massachusetts Motor Transportation Association presentation to the EPA) include automatic shut-down/start-up systems, auxiliary power unit/generator sets, diesel-driven heating systems, and battery powered systems. SmartWay sites possible fuel savings of 1 gallon per hour with such systems in place, as well as a lessening particulate matter emission. Driver incentives for reducing idling time and thus mpg could be offered.

Fuel Operated Heaters (FOH)

An FOH provides heat only. The EPA has determined through its own test program that these devices reduce fuel use and emissions on Class 8 trucks when compared to the truck's baseline emissions. In addition, the California Air Resources Board (CARB) has approved certain FOHs for compliance with applicable emissions standards. Technologies include, but are not limited to, the FOHs manufactured by the following companies: Espar Heater Systems (CARB approved); Product North America, Inc. (CARB approved); Teleflex.

Battery Air Conditioning Systems (BAC)

A BAC system uses batteries to power an independent electric cooling system when the truck engine is turned off. The EPA has evaluated BACs and finds that these systems reduce emissions when compared to the truck's baseline emissions. Technologies include, but are not limited to, the BAC systems manufactured by the following companies: Autotherm Division Enthal, Bergstrom Inc.; Driver Comfort System; Dometic; DC Power Solutions; Glacier Bay; Idle Free Systems, LLC; Safer Corporation; Sun Power Technologies.

Diesel Retrofits

The Diesel Emissions Reduction Act (DERA) has established a grant and loan program to reduce emissions from existing diesel engines through clean diesel retrofits. Clean diesel retrofits yield up to 90 percent of emissions reduction from trucks and other diesel vehicles. Retrofitting is one of the quickest and most cost-effective strategies for states and localities trying to meet clean air standards.

The EPA has a diesel retrofit technology verification program that approves diesel retrofit technologies. There is a verified technologies list which provides the manufacturer, technology, applicability, and the percent reduction of emissions for each verified technology. For example, as stated in the verified technologies list, the fuel borne catalyst plus diesel oxidation catalyst provided by Clean Diesel Technologies for highway medium and heavy duty trucks has been verified to provide reductions in particulate matter by 25 to 50%, carbon monoxide (CO) by 16 to 50%, nitrogen oxide (NOx) by up to 5% and hydrocarbons (HC) by 40 to 50%.

Retrofit technologies are in three major categories:

- Technologies that alter the type of fuel used to reduce emissions
- Tailpipe retrofits to reduce emissions
- Engine compartment modifications to reduce emissions to the cabin

With the nationwide implementation of a regulation limiting sulfur levels in diesel fuel to 15ppm in 2006, emissions have been significantly reduced. This switch to cleaner fuels has allowed the use of retrofit devices that otherwise would be rendered useless with higher sulfur concentrations. For this reason, the retrofit project focuses primarily on the tailpipe modifications as follows:

Diesel Oxidation Catalysts (DOCs) range in price from $1,000-$2,000, depending upon catalyst composition and installation charges. DOCs can last upwards of 10 years, and require little to no maintenance once installed. Installation of a DOC can take between 1-3 hours.

Diesel Particulate Filters (DPFs) are capable of removing 60-90% of PM, HC, and CO when used correctly. DPFs are best suited for buses newer than 1995 in order to ensure that ideal temperatures are reached in the exhaust stream to decompose particles that accumulate in the filter. A DPF has a working life span of between 7 and 15 years, and costs $8,000-$10,000. Applicants for 20 or more buses may apply for funding for particulate filter regenerators, which must be used for all DPFs, including the ones that will be used in new 2007 diesels.

Tail pipe emission reduction system is the Diesel Multi-Stage Filter (DMF). This muffler removes 71-75% of PM, HC, and CO. The DMF is priced between $6,000- $8,000, and requires minimal maintenance. This unit is considered to be an effective compromise between the less expensive DOC and the more efficient DPF.

The crankcase is the source of the vast majority of pollution that impacts bus passengers. Emissions from the engine compartment seep through cracks and openings in windows and doors to create conditions in which the particulate matter concentrations inside the bus may be many times that of ambient conditions. Crankcase filters ultimately reduce emissions of particulate matter to the cabin by nearly 100%. Priced near $400-$700 each, CCFs achieve the highest emission reductions to the cabin per dollar. The CCF must be maintained on a regular basis by replacing the internal filter at each oil change, at a cost of approximately $50. The CCF can be used in conjunction with DMFs, DOCs, or DPFs. Both tailpipe and crankcase retrofits are beneficial to the public, reducing pollutants that reach the ambient air, as will as reducing what seeps into the cabins of buses.

The Maryland Department of the Environment's (MDE) Mobile Sources Control Program (MSCP) is actively promoting the use of retrofit technology. They discovered early on that many fleet managers are not aware of current diesel retrofit technology, or the fleet owners lacked funding to install the devices. MSCP campaigned to promote awareness of the technology through workshops, presentations and networking. MSCP also sought federal grants to help local fleets purchase and install retrofit technology. One of MSCP's first outreach efforts was holding a workshop two years ago for school bus fleet owners and operators. Today, MDE has 13 active projects with state, county, and municipal fleets. These projects are retrofitting school buses, transit buses, trash and dump trucks, ambulances and fire trucks.

Transportation Fleet Energy Utilization and Mileage Efficiency Recommendations

The following recommendations will improve fuel utilization and mileage efficiency:

- The primary fossil fuels utilized should be gasoline with a 10% ethanol blend and diesel with a summer B20 bio-diesel blend & winter with a B5 bio-diesel blend.
- Ethanol fuel conversion is considered not cost effective at this time. This option should be evaluated again in 2012.
- Vehicles should be purchase based on the best in class fuel economy standards when fueled by gasoline or diesel.
- Hybrid vehicles should be purchased when replacing sedan vehicles.
- Sedan vehicles should be used rather than trucks or SUVs unless the vehicle will be used for heavy duty work and cargo applications.
- SUV hybrid vehicles are preferred over the purchase of gasoline-only fueled models.
- Diesel fuel trucks larger than ¾ tons should be purchased for heavy duty work and cargo applications and fueled with a bio diesel fuel blend.
- Vehicles should be down-sized to improve efficiency.
- Standards should be developed to size the vehicle to meet the user's job requirements and not user preferences to improve overall fleet performance.
- Vehicles should not be assigned to users that drive fewer than 3,000 miles per year, 250 miles per month, 12.5 miles per work day, especially if the miles driven are from home to work.
- The oldest and highest usage vehicles should be replaced within the next two years.
- Vehicles should be replaced over the next 8 to 10 years with a combination of best gas, hybrid, and diesel vehicles to provide the best overall results.
- Retrofitting existing diesel trucks with diesel particulate filters, crankcase filter's or diesel oxidation catalysts is recommended.
- Strategies to reduce diesel trucks idle time such as automatic shut down procedures, APUs and driver incentives are strongly encouraged.
- Proper maintenance and proper tire pressure is recommended.
- Large transit buses should be migrated to Hybrid Buses in the next replacement cycle estimated to begin in 2012.
- Vehicle assignment and purchasing should be centralized as follows.

Centralized Procurement Standards and Programs

Vehicles are being purchased based on the user's preference rather than matching the work requirements. SUVs seemed to be preferred when a sedan would be better suited for the daily work assignment of the user. Pick-up trucks are being used by supervisors who rarely haul materials when a sedan would be better suited for the daily work assignment of the user.

Additionally, vehicle assignments should focus on down-sizing the vehicle to improve efficiency. Furthermore, standards should be developed to size the vehicle to meet the users' job requirements and not user preferences to improve overall fleet performance.

The County should consider implementing a policy on the annual use of a vehicle to justify the need to assign a vehicle to a user. Fairfax County Virginia established a standard that a vehicle should not be assigned to a user who drives less than 3,000 miles per year, 250 miles per month, or 12.5 miles per work day, especially if the miles driven are from home to work.

PROJECTED RESULTS

Implementing the recommendations proposed in this study should improve fuel utilization and mileage efficiency by 2024 as follows:

General Fleet Vehicles		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles	774,772	16.4
Best Gas with Hybrid	**774,772**	**26.3**
Improvement		**38%**

Public Safety Vehicles		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles	3,201,941	14.6
Best Gas with Dodge Charger	**3,201,941**	**21.6**
Improvement		**32%**
Best Gas with Hybrid	**3,201,941**	**25.2**
Improvement		**42%**

Truck Vehicles		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles Gas & Diesel	2,124,128	9.8
Best Gas, Hybrid, and Bio diesel	**2,124,128**	**16.2**
Improvement		**40%**

Public Transit Large Buses		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles Diesel	566,899	3.8
Bus with Bio diesel and Hybrid Starting in 2016	**566,899**	**5.1**
Improvement		**25%**

Small Passenger Buses		
Analysis	**Total Miles**	**Average MPG**
Current Vehicles Gas & Diesel	865,260	8.7
Best Gas & Bio diesel	**865,260**	**9.5**
Improvement		**8%**

COMPREHENSIVE ENERGY MANAGEMENT PLAN RECOMMENDATIONS TO REDUCE FOSSIL FUEL USE BY 50% BY 2024

In 2008 the County purchased 1,060,023 gallons of fossil fuel for the period May 14, 2007 to May 11, 2008.

This study evaluated vehicles that used 731,940 gallons of fuel as follows.

General Fleet Vehicles		
Analysis	**Total Miles**	**Gallons**
Current Vehicles	**774,772**	**47,242**

Public Safety Vehicles		
Analysis	**Total Miles**	**Gallons**
Current Vehicles	**3,201,941**	**219,311**

Truck Vehicles		
Analysis	**Total Miles**	**Gallons**
Current Vehicles Gas & Diesel	**2,124,128**	**216,748**

Public Transit Large Buses		
Analysis	**Total Miles**	**Gallons**
Current Vehicles Diesel	**566,899**	**149,184**

Small Passenger Buses		
Analysis	**Total Miles**	**Gallons**
Current Vehicles Gas & Diesel	**865,260**	**99,455**

Total Gallons 731,940

In general the recommendations in this assessment can apply to all the licensed vehicles in the overall County fleet. The anticipated reductions in fossil fuel use should be the same for all the County vehicles.

The transition to the recommended vehicles by 2024 will reduce annual fuel use for the vehicle groups included in this study as follows:

General Fleet Vehicles				
		Current 2008	Proposed 2016	
Analysis	Total Miles	Average MPG	Average MPG	Gallons
Current Vehicles	774,772	16.4	26.3	29,459

Public Safety Vehicles				
		Current 2008	Proposed 2016	
Analysis	Total Miles	Average MPG	Average MPG	Gallons
Current Vehicles	3,201,941	14.6	25.2	127,061

Truck Vehicles				
		Current 2008	Proposed 2016	
Analysis	Total Miles	Average MPG	Average MPG	Gallons
Current Vehicles Gas & Diesel	2,124,128	9.8	16.2	131,119

Public Transit Large Buses				
		Current 2008	Proposed 2016	
Analysis	Total Miles	Average MPG	Average MPG	Gallons
Current Vehicles Diesel	566,899	3.8	5.1	111,157

Small Passenger Buses				
		Current 2008	Proposed 2016	
Analysis	Total Miles	Average MPG	Average MPG	Gallons
Current Vehicles Gas & Diesel	865,260	8.7	9.5	91,080

Total Gallons 489,876

Current Fuel Use: Existing Vehicles 731,940 gallons

Proposed by 2024 Best-in-Class Vehicles 489,876 gallons

The conversion to bio diesel does not reduce fuel use but will transition an estimated 145,600 gallons to a non-fossil fuel source by 28%.

The conversion to hybrid vehicles reduces fossil fuel consumption by the use of a non-fossil fuel source for the additional miles driven by 18%.

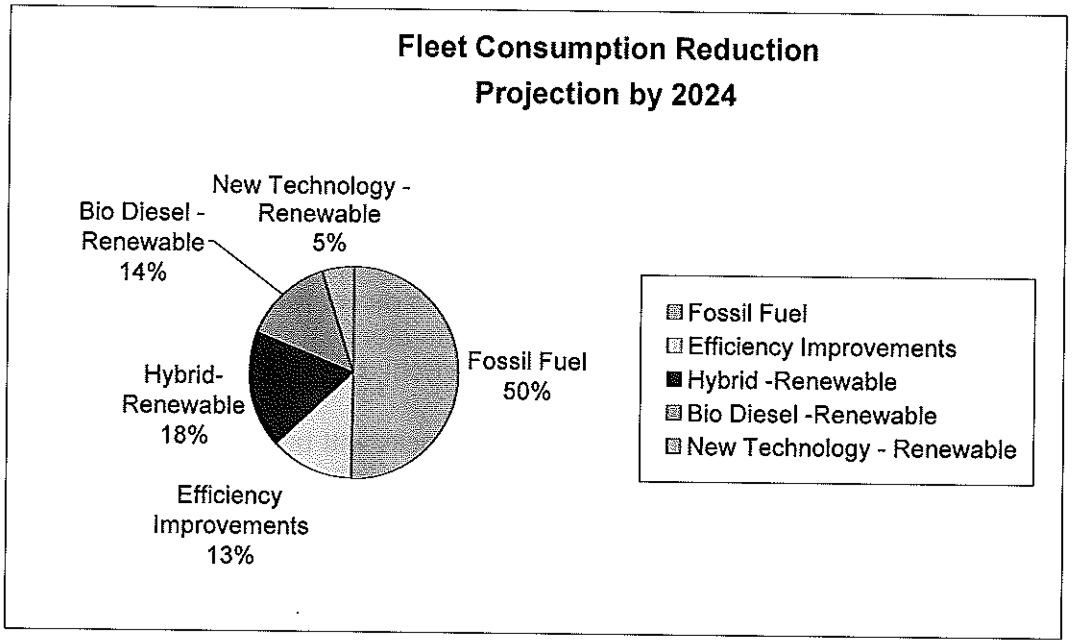
New vehicles that will be available within three to five years that will improve fuel utilization and mileage efficiency,

- Gasoline vehicle efficiency will improve in five years to meet new government standards.
- In 2009, turbo diesel pickups and vans will be available which meet new diesel efficiency specifications and use bio diesel fuels. The Dodge RAM 2500/3500 full size pickup is hailed as the cleanest diesel engine pickup on the market. B20 is approved for the Dodge Ram Turbo Diesel.
- Starting in 2011 New Light Duty Diesel trucks will be capable of using B20 bio diesel year round.
- In 2010 plug-in hybrid vehicles will be available and should be used where applicable.
- Electric vehicles should reach the market within three years and should be used where applicable.
- Fuel cell technology is anticipated to be commercially viable in ten years.

The expectation is that new technology yet to be made available will allow the County over the next 15 years to reduce fossil fuel use by over 50%

The conversion can be achieved through the application of efficiency improvements 13%, purchase of hybrid vehicles 18%, the use of bio diesel fuel 14%, and new technologies to include electric vehicles 5%.

37% of the fuel use will be from a renewable energy by 2024



IMPLEMENTATION PLAN

Fiscal Year 2010 (July 2009 to June 2010)

- Purchase new vehicles using the **Best-in-Class - Gas, Hybrid, & Bio Diesel** lists contained in this report.
- Convert to bio diesel B20 blend in the summer and B5 blend in the winter
- Implement the best management practices and operations improvements.

Fiscal Year 2011 (July 2010 to June 2011)

- Update the recommended vehicle replacement purchase list based on actual mileage data and current fuel economy specifications in www.fueleconomy.gov to select the **Best-in-Class - Gas, Hybrid & Bio Diesel** vehicles.
- Purchase new vehicles using the updated **Best-in-Class - Gas, Hybrid & Bio Diesel** list.
- Evaluate the purchase of plug-in hybrid vehicles as new vehicles are purchased starting in 2011

Fiscal Year 2012 to Fiscal Year 2016

- Update the recommended vehicle replacement purchase list based on actual mileage data and current fuel economy specifications in www.fueleconomy.gov to select the **Best-in-Class** vehicles.

- Purchase new vehicles using the updated **Best-in-Class** list.

- As new diesel fueled vehicles are purchased that are capable of operating year round on B20 blended bio diesel fuels, convert to bio diesel B20 blended fuels year round.

- Evaluate the purchase of electric vehicles as new vehicles are purchased starting in 2012.

- Re-evaluate the use of E-85 Ethanol fuel in 2012 and develop a recommendation for use starting in 2014.

- Update this study based on developing technology in 2014.

Fiscal Year 2016 to Fiscal Year 2024

- Update the recommended vehicle replacement purchase list based on actual mileage data and current fuel economy specifications in www.fueleconomy.gov to select the **Best-in-Class** vehicles

- Purchase new vehicles using the updated **Best-in-Class** list.

- Purchase hybrid transit buses as new vehicles are purchased starting in 2018

Appendix H

Change in Fuel Usage from Baseline Period by Department

First 52 weeks of Fuel Conservation 8/11/2008 to 8/9/2009

Prepared: November 3, 2009

Department Name	Dept Number	52-week Change in Gals.	52 week % Change
Health Environ	6030	-739	-13%
Health Nursing	6031	-303	-32%
Health Subs Abuse	6032	77	40%
Scott Key Buses	6321	-799	-5%
Scott Key Vans	6322	276	6%
Total Health Department		**-1,488**	**-5.4%**
Parks	4501	-1,854	-8%
Total Parks & Recreation		**-1,854**	**-7.7%**
Facility Services Warehouse	5101	-364	-26%
Maintenance	5201	-1,135	-15%
Facility Services	5301	259	37%
Fleet Service Miscellaneous Equipment	5410	-363	-62%
Fleet Services Shop Equip	5414	-879	-30%
Total Management Services		**-2,482**	**-18.9%**
Dept of Aging	7101	-1,102	-34%
Family Partnership	7201	-849	-27%
Family Partnership - Grant Fund G23179	7202	71	12%
Family Partnership - Up County	7203	-18	-1%
Head Start	7321	-271	-3%
Housing	7421	22	6%
Total Citizens Services		**-2,149**	**-13.3%**
Permits & Inspection	3210	-3,980	-31%
Office of Life Safety	3410	-273	-19%
Environmental Compliance	4220	311	15%
Total Permitting & Development Review		**-3,942**	**-24.0%**
Animal Control	9400	-784	-7%
Total Animal Control		**-784**	**-6.7%**
Library Operations	9051	-377	-8%
Total Library Operations		**-377**	**-8.5%**
Fleet Services Rental Vehicles	5413	-2,364	-28%
Total Management Services - Motorpool Rentals		**-2,364**	**-28.4%**
Johnson Grass	9221	64	2%
Total Johnson Grass		**64**	**2.3%**
Office of Emergency Preparedness	8801	-790	-59%
Division of Emergency Management	8901	226	52%
Total Division of Emergency Management		**-563**	**-31.7%**
Planning & Zoning	3010	-83	-13%
Total Planning & Zoning		**-563**	**-13.4%**
Montevue Home	9351	-99	-18%
Total Montevue Home		**-99**	**-18.2%**
Citizens Nursing	9309	-32	-8%
Total Citizens Nursing		**-32**	**-8.0%**
IIT	9141	-9	-7%
IIT Voice Services	9143	-175	-12%
Total IIT		**-184**	**-18.6%**
States Attorney	1101	-38	-25%
Total States Attorney		**-38**	**-25.3%**
Total County reduction from baseline		**-77,191**	**-7.1%**

Appendix H

Change in Fuel Usage from Baseline Period by Department

First 52 weeks of Fuel Conservation 8/11/2008 to 8/9/2009

Prepared: November 3, 2009

Department Name	Dept Number	52-week Change in Gals.	52 week % Change
Sheriff Civil	1201	-139	-3%
Sheriff Sau / Task Force	1204	3,579	32%
Sheriff Law Enforcement	1205	-12,493	-6%
Sheriff Myersville	1206	-77	-6%
Sheriff Emmitsburg	1207	-861	-20%
Sheriff Middletown	1208	-597	-14%
Sheriff Crossing Guard	1210	28	2%
Sheriff Child Support	1221	-131	-8%
Sheriff Detention Center	1250	-723	-11%
Sheriff Alternative Sentencing	1252	688	37%
Sheriff Work Release	1253	231	9%
Total Sheriff's Office		**-10,495**	**-4.0%**
Transit	7701	-324	-4%
Transit Section 18	7703	-2,016	-12.3%
Transit Section 9 Urban Transportation	7721/7702	-4,456	-3.0%
Transit SSTAP Grant	7722	1,989	7.9%
Transit ADA Grant	7723	1,133	4.0%
Total Transit		**-3,673**	**-1.6%**
DPW - Highway Operations	4111	-16,126	-9%
DPW - Transportation Engineer	4115	25	4%
DPW - Construction Management	4215	-690	-5%
Total DPW		**-16,791**	**-8.6%**
Water & Sewer Admin	4301	-118	-46%
Water & Sewer Operations	4310	-1,217	-5%
Water & Sewer Maintenance	4360	-608	-2%
Solid Waste	4401	-29,264	-26%
Total DUSWM		**-31,207**	**-18.6%**
Fire & Rescue	8001	-324	-85%
Fire & Rescue Services	8101	-2,602	-17%
Fire & Rescue Training	8102	0	N/A
Fire Marshal	8151	1,370	55%
Hazmat	8301	291	63%
Advance Life Support	8701	1,033	6%
Total DFRS -Admin/ALS/Hazmat		**-231**	**-0.6%**
Independence Fire Co	8201	-1,106	-8%
Junior Fire Co	8202	-39	0%
United Fire Co	8203	1,508	15%
Citizens Fire Co	8204	0	0%
Green Valley Fire Co	8225	299	9%
Westview (United Sub Station) Co 31	8231	-671	-12%
Spring Ridge Fire Station	8233	-735	-25%
Total DFRS Vol Companies using Fuelman		**-743**	**-1.6%**
Total DFRS Vol Companies with other sources of fuel		**2,282**	**26.7%**
Office of Volunteer Fire & Rescue Services	8260	523	48%
Total Office of Volunteer Fire & Rescue Services		**523**	**47.6%**

Appendix H

Appendix I

Solid Waste Modeling Support for Frederick County, Maryland Board of Commissioners

Final Report – July 28, 2008

Prepared by:
RTI International
Research Triangle Park, NC

Prepared for:
Frederick County

Solid Waste Modeling Support for Frederick County, Maryland Board of County Commissioners

1—Introduction and Goals

The Frederick County, Maryland Board of County Commissioners is interested in developing a more detailed and quantitative understanding of the relationships and tradeoffs between landfill and waste-to-energy (WTE) alternatives for managing post-recovery municipal solid waste (MSW). Post-recovery MSW includes residuals wastes after materials have been removed for recycling and composting.

This analysis was conducted using RTI's Municipal Solid Waste Decision Support Tool (MSW-DST). The data and results generated through this project provide a general assessment of the potential tradeoffs in cost, energy, and emissions associated with the management of post-recovery MSW in Frederick County. An analysis of other specific alternatives, waste streams, or regions may produce different results.

2—Methodology

Estimates for net total annual cost, energy consumption, and multi-media (air, water, land) emissions were calculated using RTI's MSW DST. The MSW DST is a computer-based model developed by RTI in cooperation with the U.S. Environmental Protection Agency (EPA) Office of Research and Development to assist communities and MSW planners in analyzing the full costs and life cycle environmental aspects of alternatives for MSW management. The MSW DST is populated with North American average default data, which has been modified to use site-specific data supplied by Frederick County. Users can evaluate the numerous MSW management strategies that are feasible within a community or region and identify the alternatives that are economically and environmentally efficient, making tradeoffs if necessary. The MSW DST has undergone extensive stakeholder input and peer review (as well as a separate peer review by the U.S. EPA) and is regarded as a cutting-edge software tool that can help solid waste planners make more informed decisions. Additional information about the MSW DST is supplied in Attachment A and can be obtained from RTI.

The methods used in the MSW DST to calculate the energy and environmental results are built on the principles of Life Cycle Assessment (LCA). LCA is a type of systems analysis that accounts for the complete set of upstream and downstream (cradle-to-grave) energy and environmental aspects associated with industrial systems. The technique examines the inputs and outputs from every stage of the life cycle from the extraction of raw materials, through manufacturing, distribution, use/reuse, and waste management. In the context of integrated waste management systems, an LCA tracks the energy and environmental aspects associated with all stages of waste management from waste collection, transfer, materials recovery, treatment, and final disposal. For each of the waste management operations, energy and material inputs and emissions and energy/material outputs are calculated (see Figure 1). In addition, the energy and

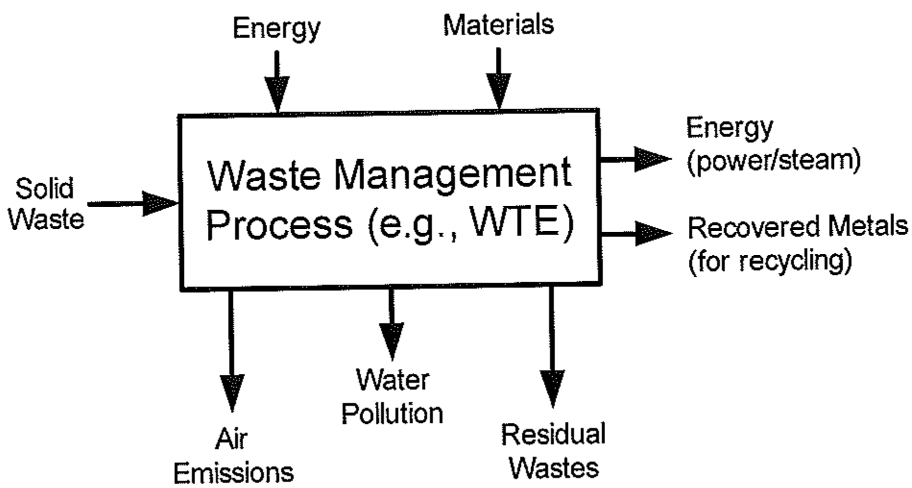


Figure 1. Life Cycle Inputs and Outputs of a Waste Management Process. All waste management processes that comprise an integrated waste management system consume energy and materials and produce emissions. Some processes, such as WTE, recover energy and materials. The benefits associated with any energy or materials recovered are captured in the life cycle study.

emissions associated with fuels, electrical energy, and material inputs are captured. Likewise, the potential benefits associated with energy and/or materials recovery displacing energy and/or materials production from virgin resources are captured in the life cycle results.

Taking a life-cycle perspective encourages waste planners to consider the environmental aspects of the entire system including activities that occur outside of the traditional framework of activities from the point of waste collection to final disposal.

3—Strategies Analyzed

The primary goal of the project was to identify and quantify the cost and environmental aspects of the management of 229,100 tons of post-recovery MSW for the following management alternatives:

1) In-County landfill disposal
2) In-County WTE with disposal of ash in a local landfill.
3) Out-of-State landfill disposal

For the landfill alternatives, it is assumed that local and out-of-state landfills are designed and operated based on the requirements established by U.S. Subtitle D landfill standards. The landfills are assumed to contain a liner system and collect and manage (i.e., treat) leachate and a gas collection system. For the in-county landfill strategy, it is assumed (based on available information) that landfill gas would be collected and flared. For the out-of-state landfill strategy, the MSW goes to multiple facilities. It is assumed that 84%

of the MSW is disposed of in landfills that collect and combust landfill gas in an internal combustion engine-generator set to generate electricity. The electricity produced is used for internal power load and the remainder is assumed to be delivered to the regional electricity grid. The remaining 16% of the MSW is assumed to be disposed of in landfills that collect and flare landfill gas.

The local WTE strategy assumes a modern mass-burn MSW combustion facility that produces electrical energy and recovers ferrous and non ferrous metal from the combustion ash. The electrical energy produced is used for internal power load and the remainder is delivered to the regional electricity grid. Ash from the combustion process is assumed to be transported and disposed of in a dedicated ash landfill. Recovered metals are assumed to be sent to a steel plant for recycling.

Table 1 lists the mass flow of waste for each strategy. The following assumptions and conditions were applied to all strategies analyzed (as appropriate):

- The quantity of post-recovery MSW managed in each strategy analyzed was assumed to be 229,100 tons per year.
- Waste composition, as shown in Table 2, is based on the average post-recovery composition of waste in Frederick County.
- Electricity consumption and related emissions are based on the Mid-Atlantic Area Council regional electricity grid mix of fuels which contains about 46% coal and 42% nuclear as the main fuels.
- 100-year time frame was used for estimating landfill gas emissions.
- Electrical energy produced from WTE and landfill gas-to-energy was assumed to offset the average regional electricity grid mix of fuels which contains about 94% coal, 1.5% natural gas, and 4.5% other (e.g., biomass).

Key assumptions used in this analysis by waste management process are listed in Table 3.

Table 1. Mass Flow of Waste for the Scenarios Analyzed (wet tons).

	Annual Tons Managed		
	Local LandFill	**Local WTE**	**Out-of-State Landfill**
Post-Recovery MSW	229,100	229,100	229,100
Collection	229,100	229,100	229,100
Long-Haul Transfer	0	0	229,100
WTE	0	229,100	0
Local Landfill	229,100	0	0
Out-0f-State Landfill	0	0	229,100

Table 2. Post-Recovery Waste Composition.

Waste Item	Percent Composition
Paper	40%
Plastic	13%
Organic	29%
Ferrous Metal	4%
Non-Ferrous Metal	1%
Glass	2%
Wood	6%
Inorganic	4%
Yard Waste	1%
TOTAL	100%

Source: R.W. Beck. 2005. "2005 Waste Composition Study for Montgomery County, Maryland. Memorandum prepared for the Northeast Maryland Waste Disposal Authority. June 2005.

Table 3. Key Assumptions By Process Used in This Analysis.

Parameter	**Assumption**
General	
Waste Tonnage	229,100 tons
Waste Composition	See Table 2
Waste Collection Frequency	1 time per week
Transportation Distances	
Collection to local landfill	20 miles one way
Collection to local WTE	20 miles one way
Collection to transfer station	20 miles one way
Transfer station to out-of-state landfill	200 miles one way by truck
WTE	
Basic Design	Mass burn with electricity and ferrous recovery
Plant Heat Rate	17,500 btu/kwh
Ferrous Recovery Rate from Ash	88%
Aluminum Recovery Rate	.14% of incoming waste tonnage
Assumed Offset for Energy Recovery	Average regional utility grid mix of fuels based on 94% coal, 1.5% natural gas, and 4.5% other.
Landfill	
Basic Design	Conventional, Subtitle D Type
Time Period for Calculating Emissions	100 years
Landfill Gas Collection Efficiency	75%
Landfill Gas Oxidation Rate	15%
Landfill Gas Management	Flare for local. 84% energy recovery, 16% flare for out-of-state
Assumed Offset for Energy Recovery	Average regional utility grid mix of fuels based on 94% coal, 1.5% natural gas, and 4.5% other.

4.0 Results

The summary level results for each scenario analyzed are shown in Table 4. Results are presented as net totals for each scenario and waste management activity. Therefore, a positive value represents a net cost or emission whereas a negative value represents a net cost, energy, or emissions savings/avoidance. For example, a negative value for carbon emissions means that the MSW management strategy offsets (or avoids) more carbon equivalent emissions than it produces by virtue of energy and materials recovery and displacing utility sector energy production and/or materials production from virgin resources, respectively.

Results for annual cost, energy consumption, criteria air pollutants and greenhouse gases (carbon emissions) have been charted in Figures 2 through 5 and are discussed below.

4.1 Net Cost

The cost modeled by the MSW DST is consistent with "full cost accounting" principles. It includes the capital, operating and maintenance, and labor costs over the life of the facilities included in each scenario. Therefore, the cost is not necessarily representative of the tip fee charged by any facility. For facilities recovering energy and/or materials and selling them to create revenue, this revenue stream is netted out of the cost. The cost results therefore represent a net annual cost.

Figure 2 shows the annual net cost (total expenses minus revenues) results for the scenarios analyzed. In general, the net cost for the local landfill and WTE alternatives are about the same at approximately $100/ton with the out-of-state landfill cost higher due to the need for waste transfer and out-of-state transportation and is approximately $125/ton.

The cost results presented are not "tipping fees" but rather include all capital and operating costs from the point of waste collection to final disposition. The cost for the landfills uses a provided landfill cost of $57/ton escalated by 4% to the year 2012. Cost for the WTE facility uses a provided estimate for 2012 electricity sale price of $73.86/MWh. The costs represent average costs for landfill and WTE processes and actual costs for specific facilities may be different, particularly in different regions.

Table 4. Summary Level Results.

Parameter	Units	Local Landfill	Local WTE	Out-Of-State Landfill
Cost	US$	22,918,622	22,512,705	28,841,869
Energy Consumption	MBTU	161,504	-2,443,433	-131,968
Air Emissions				
Total Particulate Matter	lb	21,534	-362,515	-61,701
Nitrogen Oxides	lb	173,897	-428,322	1,746
Sulfur Oxides	lb	29,652	-1,456,256	-393,384
Carbon Monoxide	lb	769,237	-192,123	305,880
Carbon Dioxide Biomass	lb	247,853,167	401,689,556	247,508,214
Carbon Dioxide Fossil	lb	5,208,127	-216,593,839	-54,899,805
Carbon Equivalents	MTCE	18,854	-28,137	10,215
Hydrocarbons (non CH4)	lb	24,280	83,089	45,147
Lead	lb	0	8	-3
Ammonia	lb	4	-298	-69
Methane	lb	6,335,978	-494,011	6,181,406
Hydrochloric Acid	lb	10,000	5,317	4,539
Ancillary Solid Waste*	lb	795,054	-48,521,358	-12,284,278
Water Emissions				
Dissolved Solids	lb	14,184	-93,608	3,823
Suspended Solids	lb	1,247	-160,359	-46,333
BOD	lb	262,058	-82	261,720
COD	lb	534,308	174	535,119
Oil	lb	39,576	1,612	42,555
Sulfuric Acid	lb	13	-2,248	-675
Iron	lb	63	-12,116	-3,649
Ammonia	lb	4,687	-780	4,691
Copper	lb	0	0	0
Cadmium	lb	1	-4	0
Arsenic	lb	0	0	0
Mercury	lb	0	0	0
Phosphate	lb	50	-1,083	-294
Selenium	lb	0	0	0
Chromium	lb	1	-4	0
Lead	lb	0	0	0
Zinc	lb	0	-1	0

*Includes primarily solid waste generated from energy and/or materials production processes.

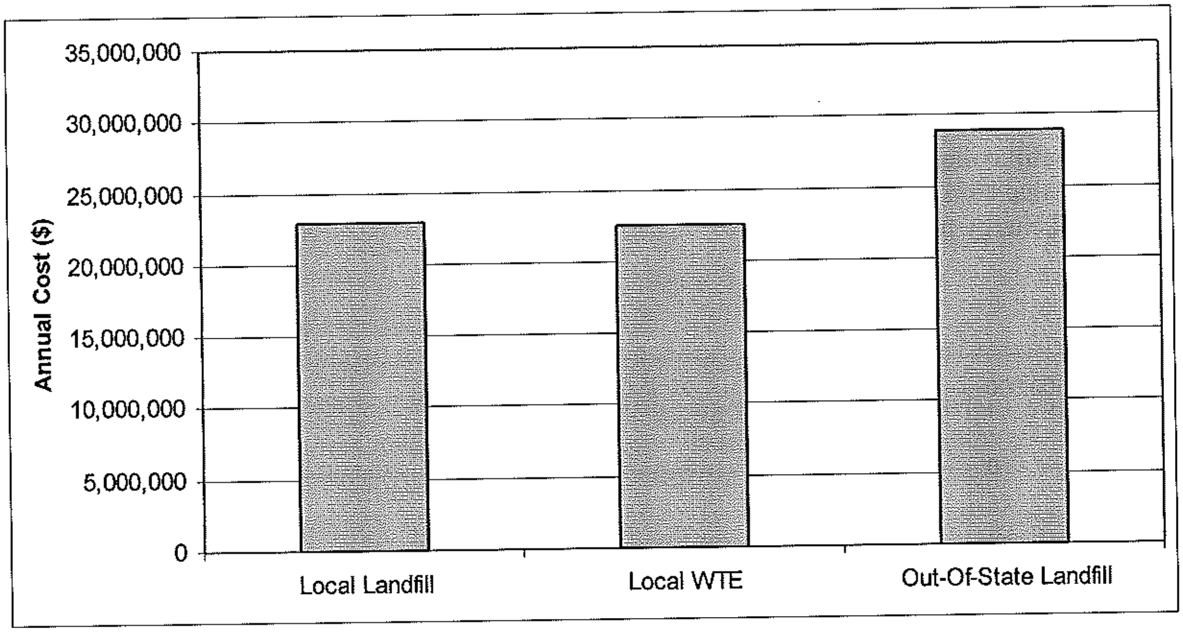


Figure 2. Annual Net Cost by Strategy.

4.1 Net Energy Consumption

Energy is consumed by all waste management activities (e.g., landfill operations), as well as by the processes to produce energy and material inputs (e.g., diesel fuel, landfill liner) that are included in the analysis. Energy can also be produced by some waste management activities (e.g., landfill gas-to-energy, WTE) and can be offset or avoided by other activities (e.g., metals recovery and recycling from combustion ash). If the energy produced and/or offset by the waste management system is greater than the energy consumed, then a net energy savings is achieved. Energy use (or savings) is an important parameter in life-cycle studies, because it often drives the results of the study due to the significant amounts of air and water emissions associated with energy production.

As shown in Figure 3, the local WTE strategy results in large net energy savings. The net energy savings from WTE strategy results from the following key aspects:

- Energy production offsets the production of energy in the petroleum and utility sectors.
- Metals recovery and recycling from WTE combustion ash offsets the consumption of energy otherwise needed to extract and process virgin materials to manufacture metals.

The contribution of materials and energy recovery to the overall energy savings varies. The savings associated with materials recycling is approximately the same on a btu-saved basis as the savings associated with energy recovery, based on the assumed tonnage of materials recycled and the tonnage input to (and amount of energy recovered) in the WTE process. If materials recycling were not included in WTE strategy, the total net energy savings would be approximately half the value as presented in Table 4 and Figure 3.

Figure 3 also shows the impact of landfill gas-to-energy on net energy consumption. The local landfill collects and flares landfill gas while for the out-of-state landfill strategy it is assumed that 84% of the MSW is sent to landfills that collect and utilize landfill gas for electrical energy production.

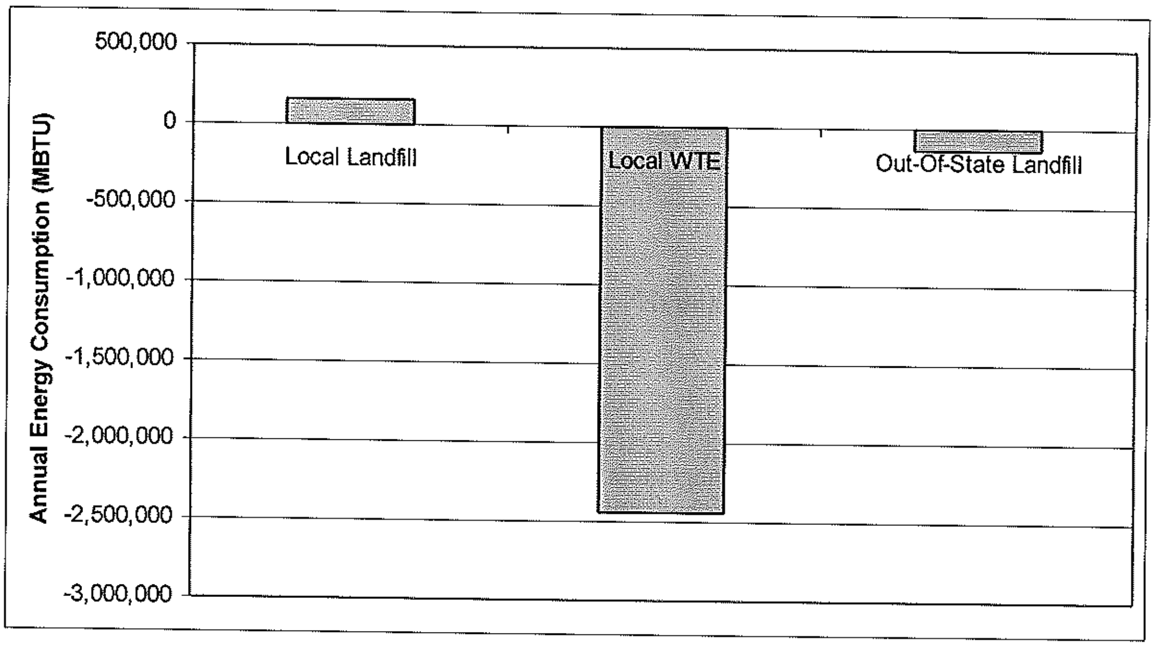


Figure 3. Net Energy Consumption by Strategy.

4.2 Criteria Pollutants

Figure 4 illustrates the results of the different MSW management strategies with respect to emissions of criteria air pollutants, including particulate matter (PM), sulfur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO), and lead (Pb). Because criteria pollutants are highly correlated to energy production, the differences in criteria pollutants generally tend to track with the differences in net energy consumption between the strategies. On a life-cycle basis, transportation is a relatively insignificant factor when compared to energy and materials production (or recovery).

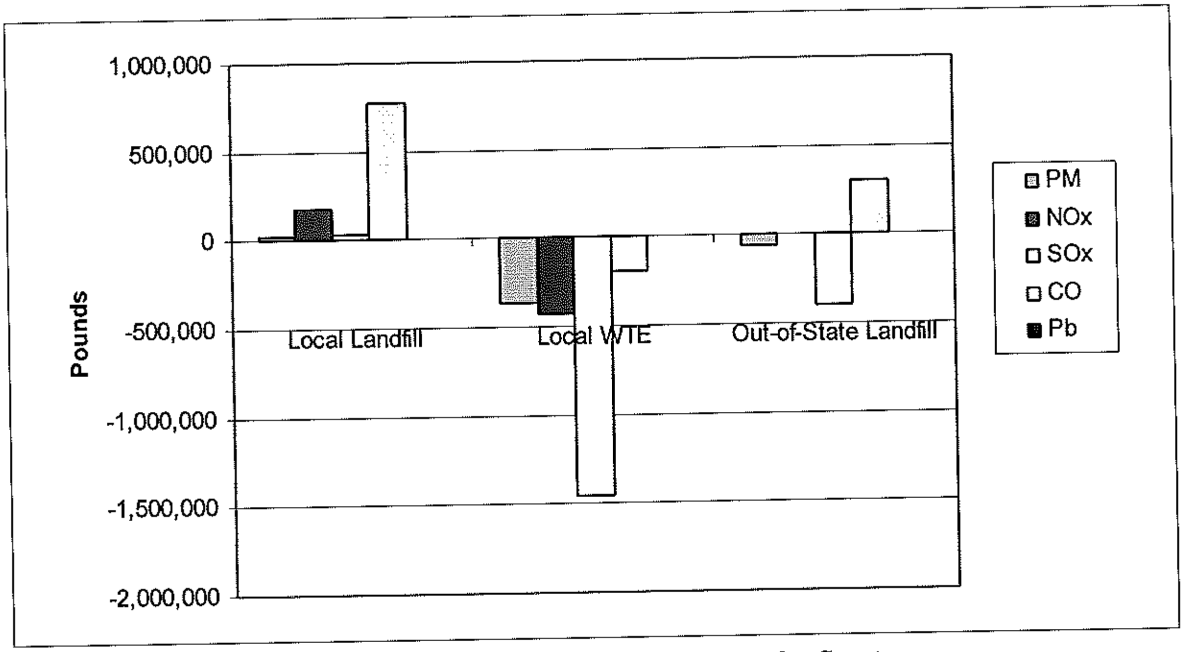


Figure 4. Net Total Criteria Pollutant Emissions by Strategy.

4.2.1 Particulate Emissions

Particulate matter, or PM, is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. They come from a variety of sources and, in the case of waste management and this study, result largely from fuels combustion in vehicles, combustion of waste, and combustion of fuels for the production of electrical energy. PM is a major source of haze that reduces visibility, can cause erosion of structures, and can lead to health effects associated with lung and heart disease.

As shown in Figure 4, the local WTE and out-of-state landfill strategies result in a net PM offsets, which means a greater amount of PM emissions are avoided that are created by virtue of materials and energy recovery. The WTE strategy has a higher avoidance of PM emissions than the out-of-state landfill strategy due to the displacement of greater amount of power produced in the utility sector (i.e., on a per ton basis, WTE produces a greater energy offset)

4.2.2 Nitrogen Oxide Emissions

NOx emissions can lead to such environmental impacts as smog production, acid deposition, and decreased visibility. NOx emissions are largely the result of fuel combustion and typically are largest for waste collection activities. Offsets of NOx emissions can result from the displacement of energy production and/or the recycling of materials (which also saves energy).

Figure 4 shows the same trend in NOx emissions as for PM. The WTE strategy exhibits a large NOx savings. The out-of-state landfill strategy, due to its large percent of gas-to-energy reduces NOx as compared to the local landfill option with gas flaring. Again, the amount of NOx emissions offset by each strategy is governed largely by the NOx emissions associated with electrical energy production in the regional electricity grid mix of fuels.

4.2.3 Sulfur Oxide Emissions

SOx emissions can lead to such environmental impacts as acid deposition, corrosion, and decreased visibility. Similar to NOx emissions, SOx emissions are largely the result of fuel combustion processes. Likewise, SOx emission offsets can result from the displacement of combustion activities, mainly fuels and electrical energy production, as well as the use of lower sulfur-containing fuels.

Figure 4 shows that the WTE and out-of-state landfill strategies result in net offsets of SOx emissions. The WTE strategies has a larger net offset than the any of the landfill strategies due primarily to its efficiency at recovery energy and offsetting fossil based electrical energy production.

4.2.4 Carbon Monoxide Emissions

CO is a colorless, odorless gas that is formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust, which contributes about 56% of all CO emissions nationwide. Other sources of CO emissions include industrial processes (such as metals processing and chemical manufacturing) and power production. CO contributes to the formation of smog, which can trigger serious respiratory problems.

Figure 4 illustrates that CO follows the same trend as seen in the PM, NOx, and SOx emissions; that is, the greater the level of recycling and energy recovery, the lower the CO emissions (or greater the CO emissions offset). The WTE strategy exhibits the greatest level of net offset for CO emissions.

4.2.5 Lead Emissions

The major sources of lead emissions have historically been motor vehicles (such as cars and trucks) and industrial sources. Due to the phase-out of leaded gasoline, metals processing is the major source of lead emissions to the air today. The highest levels of lead in air are generally found near lead smelters. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers. People, animals, and fish are mainly exposed to lead by breathing and ingesting it in food, water, soil, or dust. Lead accumulates in the blood, bones, muscles, and fat, leading to a variety of health effects. Infants and young children are especially sensitive to even low levels of lead.

As shown in Figure 4, lead emissions are too small from most scenarios to show up on the chart. The highest levels of lead emissions result from the WTE strategy and are directly related to the combustion process itself.

4.3 Carbon Emissions

Carbon emissions contribute to the greenhouse effect; thus, these emissions can lead to climate change and its associated impacts. Carbon emissions can result from the combustion of fossil fuels and the biodegradation of organic materials (e.g., methane gas from landfills). Offsets of carbon emissions can result from the displacement of fossil fuels, materials recycling, and the diversion of organic wastes from landfills. We report carbon emissions in units of MTCE, derived as follows:

$$\mathbf{[(Fossil\ CO_2*1 + CH_4*21)*12/44]\ /\ 2200}$$

As shown in Figure 5, the WTE strategy results in a net offset of carbon emissions. These offsets are directly related to the following aspects:

- Electrical energy production offsets carbon emissions from the generation of electrical energy using fossil fuels in the utility sector.
- Materials recovery and recycling offsets carbon emissions by avoiding the consumption of energy that otherwise would be used in materials production processes.
- Landfill disposal, which creates methane gas, a potent GHG, is avoided.

The figure also illustrates the impact that moving from a landfill gas flaring to energy recovery system has on carbon emissions.

In all strategies, the amount of carbon emissions avoided via energy recovery is highly dependent on the mix on fuels that is displaced on the regional electrical energy grid. If the grid mix is largely comprised of fossil fuels, the offset with be greater than a case where the regional grid mix is comprised of significant nuclear or renewable power sources. In this analysis, the regional grid is primarily coal.

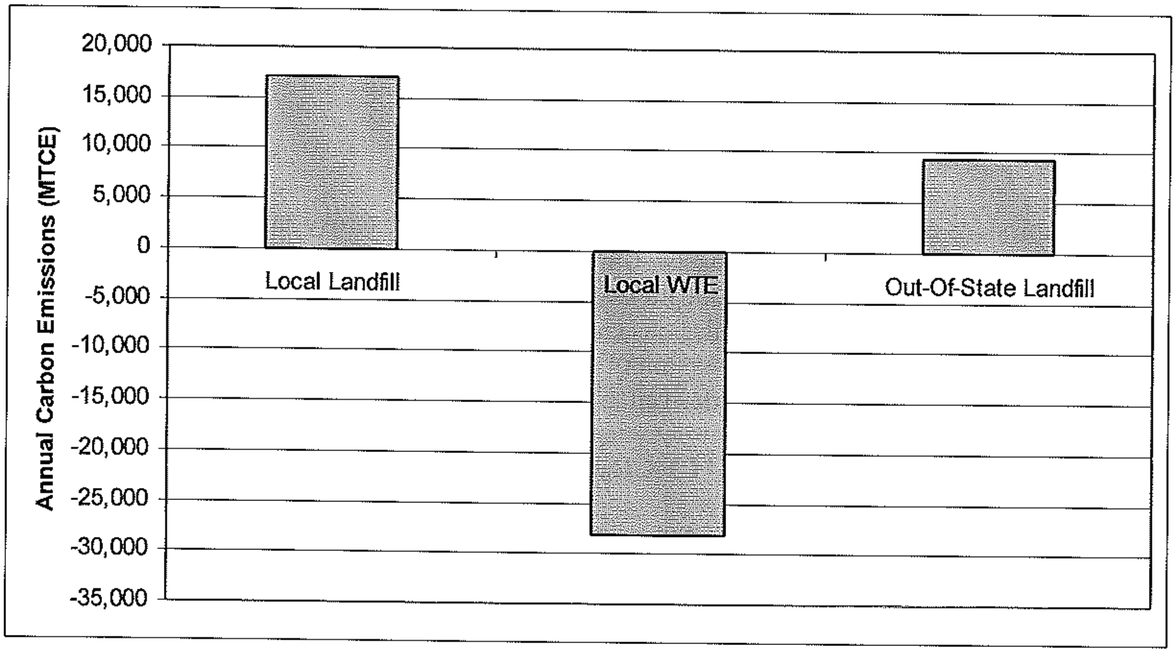


Figure 5. Net Total Carbon Equivalent Emissions by Scenario.

5.0 Conclusions

The results of this analysis are useful for identifying the potential cost and environmental implications for post-recovery MSW management strategies and to demonstrate tradeoffs exist between cost and environmental aspects. On a cost basis, it appears that the local landfill and WTE alternatives are comparable and less expensive than the out-of-state landfill alternative. On an environmental basis, it appears that the higher materials and energy recovery associated with the WTE alternative creates significant environmental benefits as compared to the landfill alternatives. On a greenhouse gas basis, the WTE strategy can reduce/avoid approximately 35,000 to 45,000 MTCE per year as compared to the alternative landfill strategies.

The results presented in this report should be used as general indicators since they represent process averages. Analyses of specific technologies or facilities may produce different results.

Attachment A
Background Information About the MSW DST

The MSW DST was developed through a cooperative agreement between the U.S. EPA's Office of Research and Development and RTI's Center for Environmental Analysis to assist communities and other waste planners in conducting cost and environmental modeling of MSW management systems. Users can evaluate the numerous MSW management strategies that are feasible within a community or region and identify the alternatives that are economically and environmentally efficient, making tradeoffs if necessary.

The MSW DST allows users to analyze existing waste management systems and proposed future systems based on user-specified information (e.g., waste generation levels, waste composition, diversion rates, infrastructure). The current components included in the MSW DST are waste collection, transfer stations, material recovery facilities (MRFs), mixed MSW and yard waste composting, combustion and refuse-derived fuel production, and conventional or bioreactor landfills. Existing facilities and/or equipment can be incorporated as model constraints to ensure that previous capital expenditures are not negated by the model solution.

As illustrated in Figure 1-1, the MSW DST consists of several components, including process models, waste flow equations, an optimization module, and a graphic user interface (GUI). The process models consist of a set of spreadsheets developed in Microsoft Excel. These spreadsheets use a combination of default and user-supplied data to calculate the cost and life-cycle coefficients on a per unit mass basis for each of the 39 MSW components being modeled for each solid waste management unit process (collection, transfer, etc.). Each process model describes and represents the essential activities that take place during the processing of waste items. For example, the collection model includes parameters for waste collection frequency, collection vehicle type and capacity, number of crew members, and number of houses served at each stop. Although national average default values are included in the MSW DST for such parameters, users can override the default values with site-specific information. These operational details, which are input by the user to represent an MSW management system, are then synthesized in the process model to estimate the cost of processing as a function of the quantity and composition of the waste entering that process. The resulting cost coefficients from each waste management process model are then used to estimate the cost of that option.

The MSW DST also contains models for ancillary processes that may be used by different waste management processes. These models calculate emissions for fuels and electrical energy production, materials production, and transportation. Electricity, for example, is used in every waste management process. Based on the user-specified design information and the emissions associated with generating electricity from each fuel type, the MSW DST calculates coefficients for emissions related to the use of a kilowatt hour of electricity. These emissions are then assigned to waste stream components for each facility that uses electricity and through which the mass flows. For example, MRFs use electricity for conveyors and facility lighting. The emissions associated with electricity generation would be assigned to the mass that flowed through that facility. Users can specify whether the emissions associated with generating electrical energy are based on a national, regional, or user-defined mix of fuel.

The optimization module is implemented using a commercial linear programming solver called CPLEX. The model is constrained by mass flow equations that are based on the quantity and composition of waste entering each unit process and that intricately link the different unit processes in the waste management system (i.e., collection, recycling, treatment, and disposal options). These mass flow constraints preclude impossible or nonsensical model solutions. For example, these mass flow constraints will exclude the possibility of removing aluminum from the waste stream via a mixed waste MRF and then sending the recovered aluminum to a landfill. The optimization module uses linear programming techniques to determine the optimum solution consistent with the user-specified objective and mass flow, and user-specified constraints. Examples of user-specified constraints are the use of existing equipment/facilities and a minimum recycling percentage requirement.

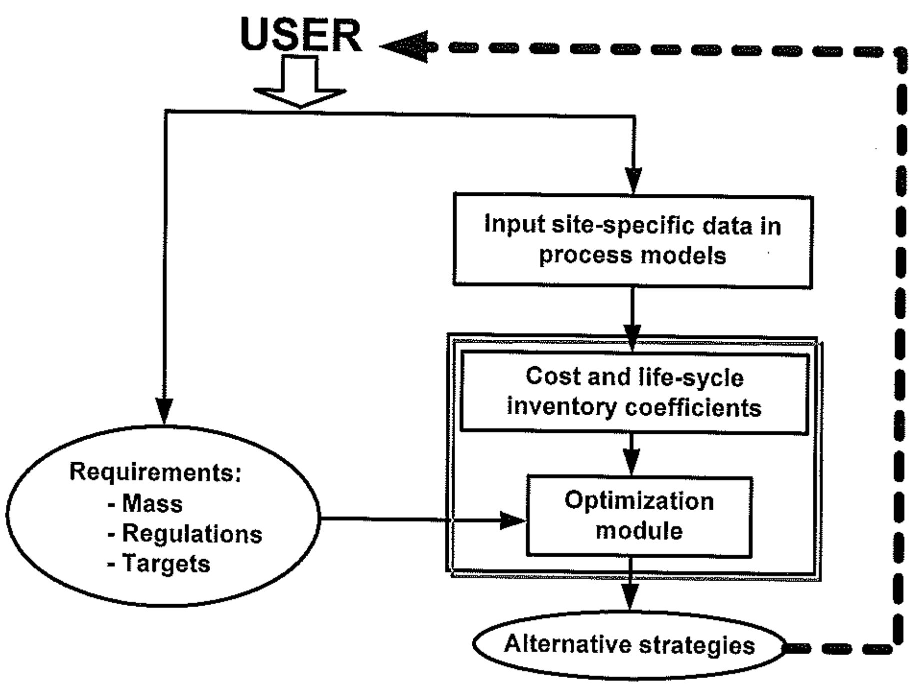


Figure 1-1. Conceptual Framework for the MSW DST.

The environmental aspects associated with a defined MSW management strategy are estimated in terms of annual net cost, energy consumption, and environmental releases (air, water, solid waste). For example, waste collection vehicles consume fuel and release several types of air pollutants in their exhaust. The collection process model of the MSW DST uses information about the quantity and composition of waste generated and a host of collection route parameters to estimate the amount of fuel consumed and air emissions by waste constituent collected. In addition, the environmental burdens associated with producing the fuel used in the collection vehicles are calculated and included in the collection results. All process modules in the MSW DST operate in a similar manner and express results as a function of the quantity and composition of the waste entering each process.

In some waste management processes, cost, energy, and emission offsets may occur. For example, diverting recycling materials from the waste stream results in a revenue stream and can displace energy consumption and emissions associated with virgin materials production. Similarly, waste management processes that recover energy (e.g., WTE, landfill gas utilization) will displace energy production in the utility sector and thereby avoid fossil fuel production- and combustion-related emissions. In applying the MSW DST, any materials or energy recovery-related benefits are netted out of the results for each process.

Attachment B
Sensitivity Analysis for Key Parameters

In this attachment, sensitivity analysis results are presented for three main items of the analysis based on issues and concerns raised by reviewers, including:

1. The use of rail haul instead of truck haul for out-of-state landfill disposal;
2. Changing electrical energy grid mix of fuels; and
3. Increasing recycling rates over time and its impact on waste available for WTE.

Analyses of these conditions were conducted to observe their impact on the net total results to determine their significance.

B.1 Analysis of Truck versus Rail Haul for out-of-state landfill disposal:

To investigate the impact and sensitivity of using rail haul instead of truck haul for out-of-state landfill disposal, the following scenarios were analyzed:

- Out-of-state landfill disposal with original truck haul (200 mile)
- Out-of-state landfill disposal with 100 mile rail haul
- Out-of-state landfill disposal with 150 mile rail haul
- Out-of-state landfill disposal with 200 mile rail haul

The results from these scenarios are illustrated in Figures B-1 through B-3. In general, rail haul is shown to be a more cost and energy efficient mode to transport waste (see Figure B-1). For energy, the results are all negative values because the out-of-state landfill recovers energy from landfill gas (see also Figure 3 in the main portion of the report). The negative value can be interpreted as follows: the amount of energy to collect, transport, and dispose of the waste is less than the amount of electrical energy recovered from combusting the landfill gas in an internal combustion energy generator set. This also includes "upstream" energy savings associated with not having to produce fossil fuels for electricity production. At the comparable haul distance of 200 miles, the net difference between the truck and rail haul scenario can be taken and shows that the rail haul scenario consumes approximately 25,000 MBTU less than the truck haul scenario.

On a greenhouse gas basis, Figure B-3 shows that the truck and rail haul scenarios do not appear to be significantly different. In general, transportation is not typically a significant contributor to greenhouse gas emissions in waste management analyses. However, the transportation sector as a whole in the U.S. is a large contributor. The key greenhouse gas driver in waste management analyses is landfill gas emissions.

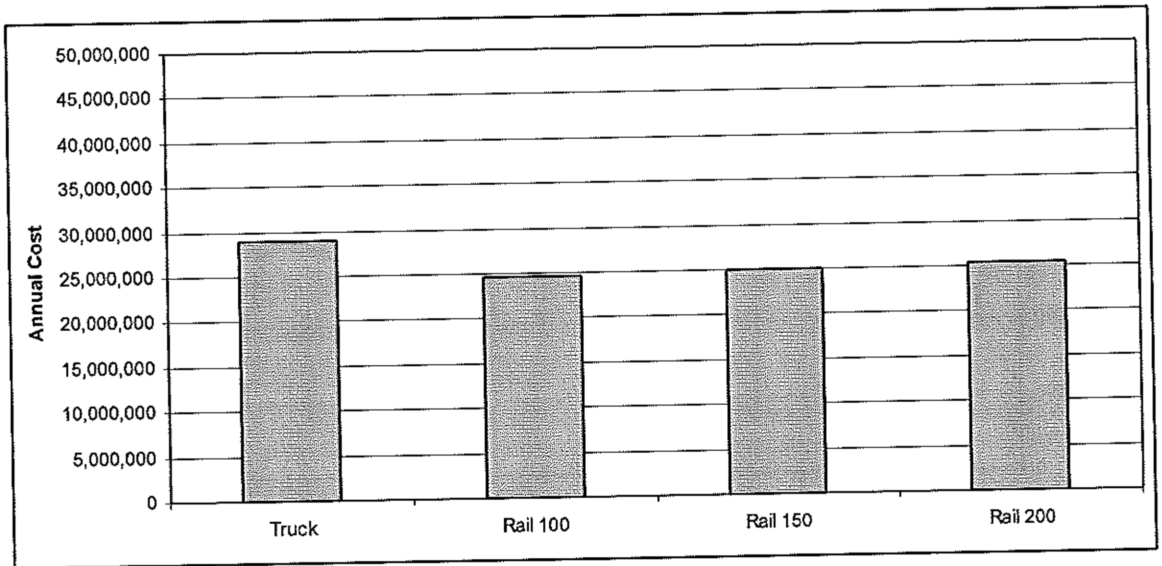


Figure B-1. Cost Sensitivity Results for Long-Haul Transportation Using Truck and Rail Modes and Variation of Rail Haul Distance.

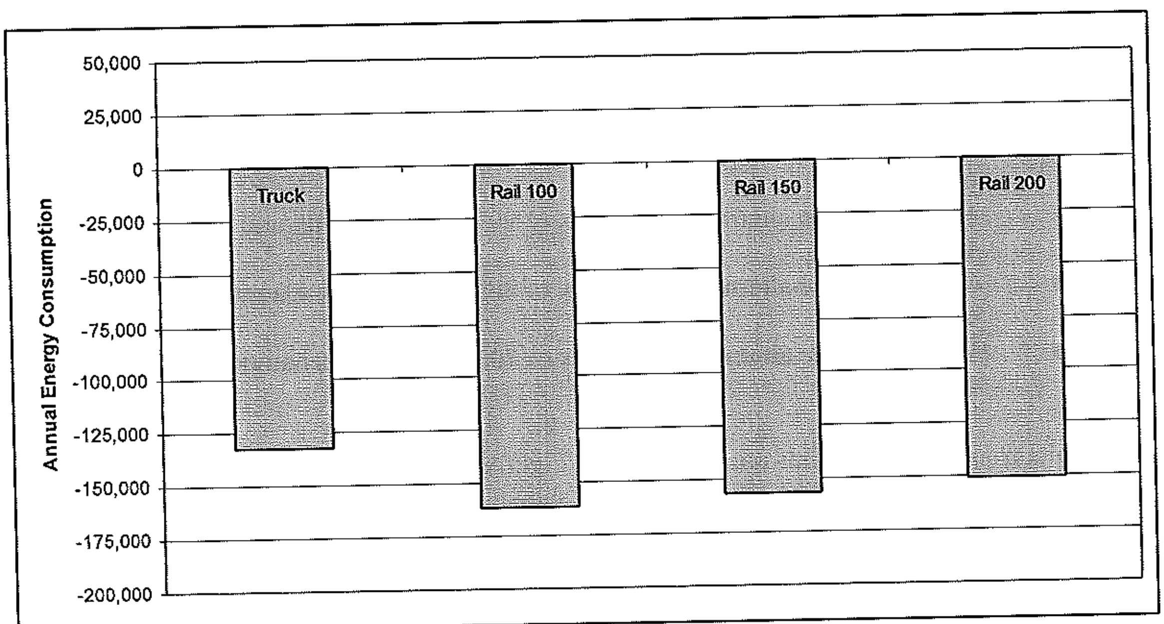


Figure B-2. Energy Consumption Sensitivity Results for Long-Haul Transportation Using Truck and Rail Modes and Variation of Rail Haul Distance.

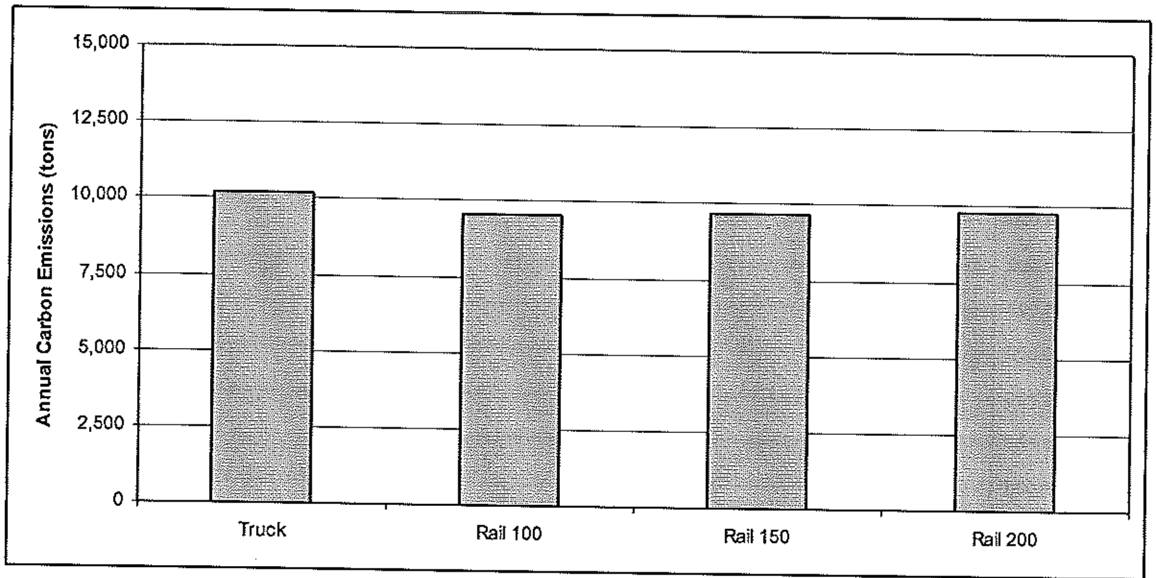


Figure B-3. Carbon Emission Sensitivity Results for Long-Haul Transportation Using Truck and Rail Modes and Variation of Rail Haul Distance.

B.2 Analysis of Changing Electrical Energy grid mix of fuels over time

To investigate the impact and sensitivity of changing the electrical energy grid mix of fuels on the net total WTE scenarios, the following scenarios were analyzed:

- WTE using the original grid mix of 94% coal, 1.5% natural gas, and 4.5% other.
- WTE using the alternative grid mix of 90% coal, 5.5% natural gas, and 4.5% other.
- WTE using the alternative grid mix of 80% coal, 15.5% natural gas, and 4.5% other.
- WTE using the alternative grid mix of 70% coal, 25.5% natural gas, and 4.5% other.

The results from these scenarios are illustrated in Figures B-4 and B-5. In general, the amount of energy consumed remains the same as shown in Figure B-4. On a greenhouse gas basis, Figure B-5 shows that the change in the grid mix as analyzed does not have a significant impact on greenhouse gas emissions.

If the analysis looked instead at displacing coal and/or natural gas with more non-fossil fuels (e.g., biofuel) or other alternative energy sources (e.g., solar, wind, hydro), then the impact would likely be more significant.

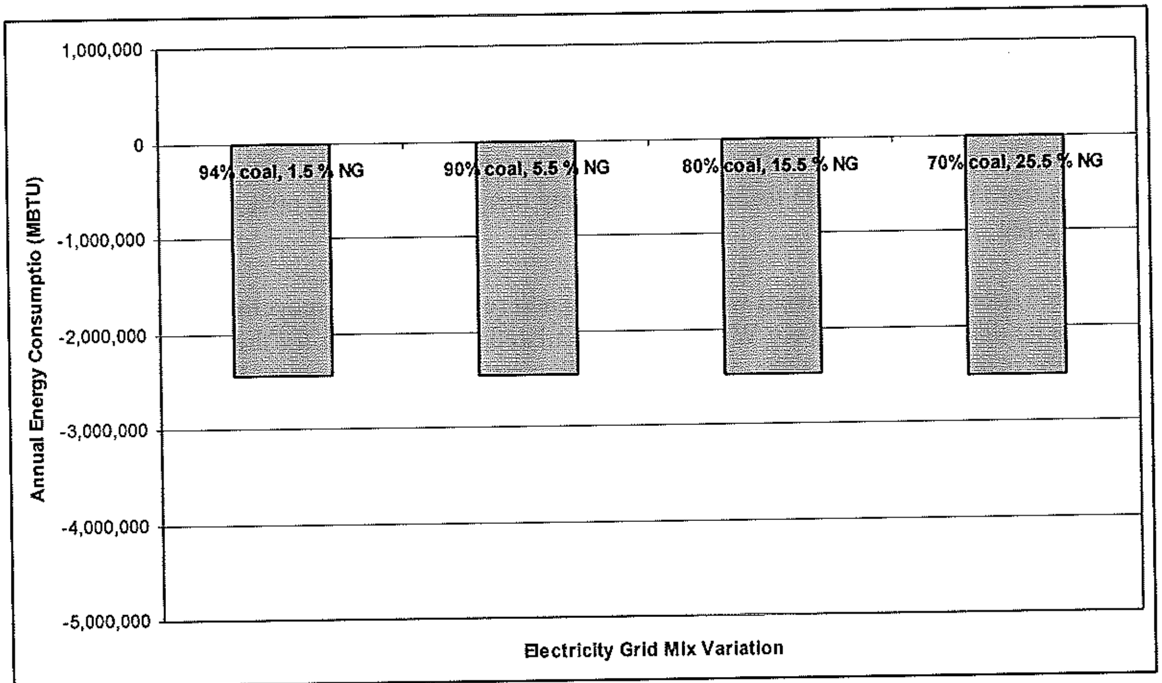


Figure B-4. Energy Consumption Sensitivity Results for WTE Using Alternative Electricity Grid Mixes of Fuels.

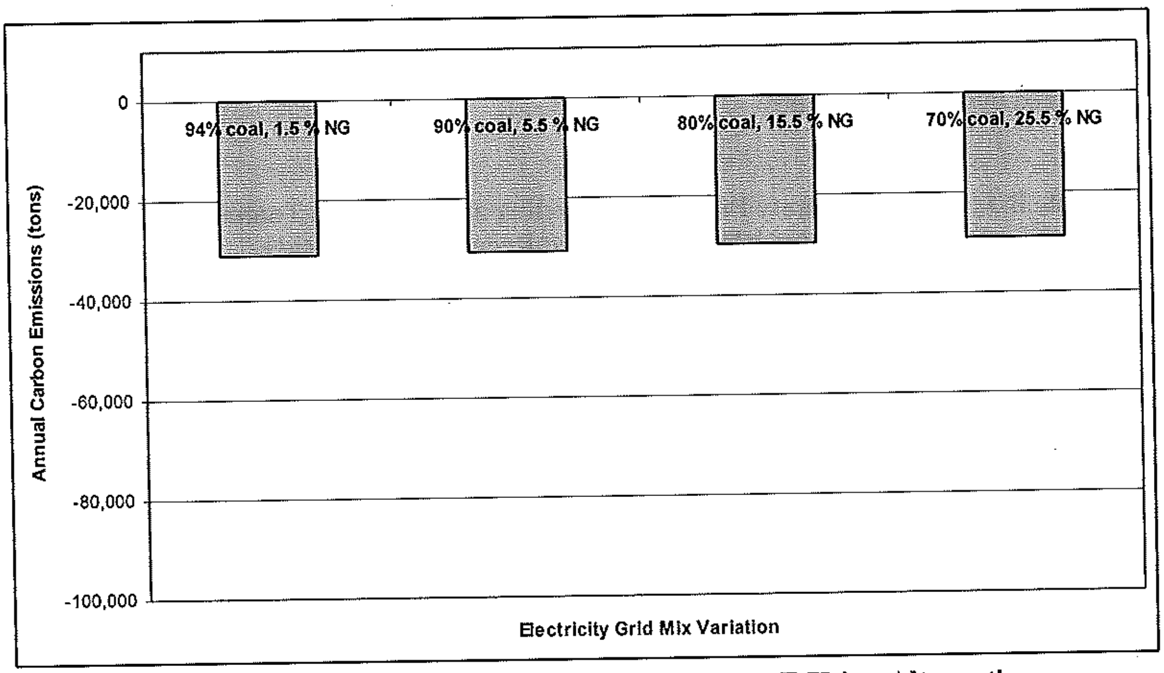


Figure B-5. Carbon Emission Sensitivity Results for WTE Using Alternative Electricity Grid Mixes of Fuels.

B.3 Analysis of Increasing Recycling Rates Over Time

In addition to the sensitivity analyses conducted for the use of rail haul instead of truck haul for out-of-state landfill disposal and changes in the electrical energy grid mix of fuels, a sensitivity analysis was also conducted to investigate the impact of recycling rate increases from the period 2005 to 2024. The county has a goal to reach 60% recycling by the year 2024.

Shown in Table B-1 is the current waste recycling and residuals (post-recycling waste that must be disposed or used for WTE). The calculated recycling rate for these current projections is approximately 37%. As new recycling rate goals are implemented, the amount of waste recycled increases proportionately to the tonnage generated in a given year. Likewise the amount of residual waste increases based on the growth in waste generation over time and also decreases depending on the amount of waste recycled. For example, as shown in Table B-1, the tonnage of waste generated is projected to increase from 321,700 tons in 2005 to approximately 460,300 tons by 2024. As the recycling rate increases over the same time period from 35% in 2005 to 60% in 2024, the amount of waste recycled increases from 112,300 tons in 2005 to 276,200 tons in 2024. The amount of residual waste remaining after recycling remains steady and then decreases slightly as recycling rates are pushed up past 50%. If waste generation increases faster than projected in the table, then more waste will be recycled and more residual will remain for landfill disposal or WTE. Likewise, if waste generation increases at a slower rate than projected, then less waste will be recycled and less residual will remain for landfill disposal or WTE. The "Adjusted Residual" values represent annual averages that do not include C&D wastes. Therefore they do not represent the total waste amount that has to be managed by a disposal facility.

Table B-1. Current County Projected Recycling and Residuals Tonnage and Projected Tonnage Using Proposed Recycling Rate Goals.

	2,005	2,010	2,015	2,020	2,024
Residuals	209,400	222,540	242,566	268,237	290,349
Recycled (No C&D)	112,294	129,675	142,010	157,039	169,984
Total Tonnage	321,694	352,216	384,576	425,276	460,332
Percent Recycled	35%	37%	37%	37%	37%
Recycling Rate Goals	35%	40%	50%	55%	60%
Adjusted Residual	209,400	211,329	192,288	191,374	184,133
Adjusted Recycled	112,294	140,886	192,288	233,902	276,199
Materials	90,000	112,000	125,000	198,000	198,000
Composting	22,294	28,886	67,288	35,902	78,199

Although the tonnage of waste changes over time, it was projected that the composition of the waste remains constant. Recycling includes both materials recycling and organic waste composting. Given that there is a finite amount of recyclable material in the waste, once the recycling rate reaches about 55%, there is no longer readily available material (i.e., paper, plastic, glass, metals) to recycle and thus to reach the 60% goal only organics (yard and food waste) composting is employed).

Two sets of recycling scenarios were analyzed, differing only in how the post-recycling residuals are managed:

1. Recycling and landfill disposal (with gas collection and flaring) of the residuals.
2. Recycling and WTE of the residuals.

The results from these scenarios are summarized in Figures B-6 and B-7. Figure B-6 shows the net energy consumption for the recycling rate scheme and either landfill disposal of the residuals or use of the residuals for WTE. As shown in the chart, both scenarios exhibit a negative energy consumption trend. This is due to recycling of materials and associated offset of virgin materials production and related energy savings. The recycling and WTE scenario results in a greater net energy savings than the recycling and landfill scenario due to the production of electricity and associated offset of electricity produced by fossil fuels in the utility sector. The difference between the two lines gives the increased energy savings of WTE versus landfill disposal of the residuals.

Figure B-7 shows the net carbon emissions for the recycling rate scheme and either landfill disposal of the residuals or use of the residuals for WTE. Like the net energy results, both scenarios exhibit a negative carbon emission trend. This is likewise due to recycling of materials and associated offset of virgin materials production and related energy savings. The recycling and WTE scenario results in a greater net carbon emission savings than the recycling and landfill scenario due to the production of electricity and associated offset of electricity produced by fossil fuels in the utility sector as well as avoidance of landfill disposal where landfill gas (a potent greenhouse gas) would be produced. The difference between the two lines gives the increased carbon emission savings (or avoidance) of WTE versus landfill disposal of the residuals.

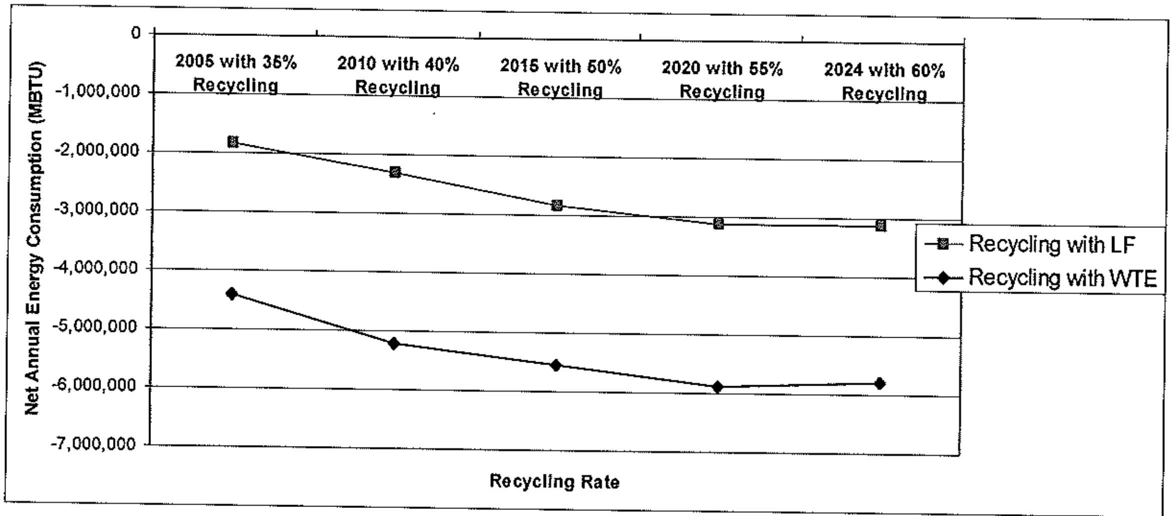


Figure B-6. Energy Consumption Results Analyzing Variations in Recycling Rates.

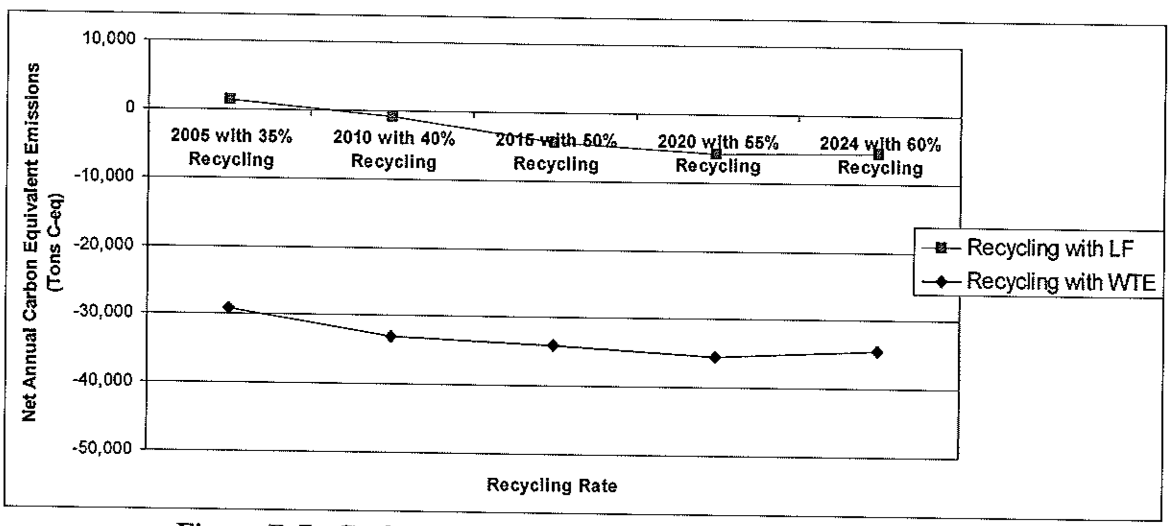


Figure B-7. Carbon Emissions Results Analyzing Variations in Recycling Rates.

Appendix J

Appendix J

COMPREHENSIVE ENERGY PLAN
ENERGY REDUCTIONS CHART

This chart should be used as a general guide to potential energy reduction outcomes. The chart tracks the cumulative effect of the Plan's recommendations on annual usage of non-renewable energy to demonstrate where the County's usage level of non-renewable energy will be each year of the 15 years of the Plan. Of primary importance is the percent reduction of the annual use of non-renewable energy by Year 15 compared to the baseline year.

- Actual results will vary depending on which recommendations are implemented, the timing of implementation, funding for the Plan, and the advances made in energy technologies over time.
- Projections become increasingly less predictable/reliable the further out in time the projection goes.

Appendix J
Reduction by Annual Percentages - Cumulative Results

Electricity Usage (BTUs)

BTU Baseline Total (Buildings):
77,316,096,541

		NRE Affected	Year 1 FY2010	Year 2 FY2011	Year 3 FY2012
	Adjusted Baseline		*77,316,096,541*	*75,926,982,335*	*73,644,141,166*
1.1	BOCC and Management support	1.00%	-0.067%	-0.067%	-0.067%
1.2	Staff education	1.00%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations				
1.4	Annual report on progress				
2.1	Energy management program	1.00%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments				
2.3	Continous investment	10.90%			
2.4	Centralized Energy Mgmt System	4.00%			
2.5	ENERGY STAR Portfolio Manager				
2.6	HVAC upgrades (current CIP projects)	4.20%		-0.700%	-0.700%
2.7	High performance energy standards	2.00%			
2.8	Onsite renewables	4.00%			-1.000%
2.9	Renewable electric purchased (kWh)	15.00%			
2.10	IIT's Technology Energy Plan (kWh only)	3.20%	-1.600%	-1.600%	
2.11	Traffic lights to LED (kWh only)	0.50%			-0.500%
2.12	Guidelines for County leased space	1.00%		-0.071%	-0.071%
2.13	Regulate # of personal appliances	0.10%		-0.100%	
2.14	Roofing materials	0.08%		-0.008%	-0.008%
2.15	Third party commissioning	5.00%		-0.357%	-0.357%
2.16	Consoldiation of government buildings	4.90%			
2.17	Future technology advancements	20.00%			
			75,926,982,335	73,644,141,166	70,927,570,792
			-1.80%	-3.01%	-3.69%
				-4.75%	-8.26%

BTU baseline Total DUSWM
59,172,751,816

			Year 1	Year 2	Year 3
	Adjusted Baseline		*59,172,751,816*	*59,172,751,816*	*12,189,586,874*
4.1	Landfill-to-Gas	79.4%		-79.400%	
4.2	Waste-to-Energy	100.0%			
4.3	Installation of solar technology	0.0%			
			59,172,751,816	12,189,586,874	12,189,586,874
			0.00%	-79.40%	0.00%
				-79.40%	-79.40%

Appendix J
Reduction by Annual Percentages - Cumulative Results

Electricity Usage (BTUs)

BTU Baseline Total (Buildings):

		Year 4 FY2013	Year 5 FY2014	Year 6 FY2015	Year 7 FY2016
77,316,096,541					
	Adjusted Baseline	*70,927,570,792*	*57,770,126,058*	*55,357,009,271*	*52,938,601,439*
1.1	BOCC and Management support	-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education	-0.067%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations				
1.4	Annual report on progress				
2.1	Energy management program	-0.067%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments				
2.3	Continous investment	-0.908%	-0.908%	-0.908%	-0.908%
2.4	Centralized Energy Mgmt System	-0.333%	-0.333%	-0.333%	-0.333%
2.5	ENERGY STAR Portfolio Manager				
2.6	HVAC upgrades (current CIP projects)	-0.700%	-0.700%	-0.700%	-0.700%
2.7	High performance energy standards			-0.200%	-0.200%
2.8	Onsite renewables				-2.000%
2.9	Renewable electric purchased (kWh)	-15.000%			-100.000%
2.10	IIT's Technology Energy Plan (kWh only)				
2.11	Traffic lights to LED (kWh only)				
2.12	Guidelines for County leased space	-0.071%	-0.071%	-0.071%	-0.071%
2.13	Regulate # of personal appliances				
2.14	Roofing materials	-0.008%	-0.008%	-0.008%	-0.008%
2.15	Third party commissioning	-0.357%	-0.357%	-0.357%	-0.357%
2.16	Consoldiation of government buildings				
2.17	Future technology advancements	-1.667%	-1.667%	-1.667%	-1.667%
		57,770,126,058	55,357,009,271	52,938,601,439	0
		-18.55%	-4.18%	-4.37%	-100.00%
		-25.28%	-28.40%	-31.53%	-100.00%

BTU baseline Total DUSWM

59,172,751,816					
	Adjusted Baseline	*12,189,586,874*	*12,189,586,874*	*12,189,586,874*	*12,189,586,874*
4.1	Landfill-to-Gas				
4.2	Waste-to-Energy				-100.000%
4.3	Installation of solar technology				
		12,189,586,874	12,189,586,874	12,189,586,874	0
		0.00%	0.00%	0.00%	-100.00%
		-79.40%	-79.40%	-79.40%	-100.00%

Appendix J
Reduction by Annual Percentages - Cumulative Results

Electricity Usage (BTUs)

BTU Baseline Total (Buildings):

		Year 8 FY2017	Year 9 FY2018	Year 10 FY2019	Year 11 FY2020
	77,316,096,541				
	Adjusted Baseline	*0*	*0*	*0*	*0*
1.1	BOCC and Management support	-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education	-0.067%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations				
1.4	Annual report on progress				
2.1	Energy management program	-0.067%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments				
2.3	Continous investment	-0.908%	-0.908%	-0.908%	-0.908%
2.4	Centralized Energy Mgmt System	-0.333%	-0.333%	-0.333%	-0.333%
2.5	ENERGY STAR Portfolio Manager				
2.6	HVAC upgrades (current CIP projects)				
2.7	High performance energy standards	-0.200%	-0.200%	-0.200%	-0.200%
2.8	Onsite renewables				
2.9	Renewable electric purchased (kWh)	3.740%	3.740%	3.740%	3.740%
2.10	IIT's Technology Energy Plan (kWh only)				
2.11	Traffic lights to LED (kWh only)				
2.12	Guidelines for County leased space	-0.071%	-0.071%	-0.071%	-0.071%
2.13	Regulate # of personal appliances				
2.14	Roofing materials	-0.008%	-0.008%	-0.008%	-0.008%
2.15	Third party commissioning	-0.357%	-0.357%	-0.357%	-0.357%
2.16	Consoldiation of government buildings				
2.17	Future technology advancements	-1.667%	-1.667%	-1.667%	-1.667%
		0	0	0	0
		0.00%	0.00%	0.00%	0.00%
		-100.00%	-100.00%	-100.00%	-100.00%

BTU baseline Total DUSWM

	59,172,751,816				
	Adjusted Baseline	*0*	*0*	*0*	*0*
4.1	Landfill-to-Gas			6.000%	6.000%
4.2	Waste-to-Energy			-6.000%	-6.000%
4.3	Installation of solar technology				
		0	0	0	0
		-100.00%	-100.00%	-100.00%	-100.00%

Appendix J
Reduction by Annual Percentages - Cumulative Results

Electricity Usage (BTUs)

BTU Baseline Total (Buildings):

		77,316,096,541	Year 12 FY2021	Year 13 FY2022	Year 14 FY2023	Year 15 FY2024
		Adjusted Baseline	*0*	*0*	*0*	*0*
1.1	BOCC and Management support		-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education		-0.067%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations					
1.4	Annual report on progress					
2.1	Energy management program		-0.067%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments					
2.3	Continous investment		-0.908%	-0.908%	-0.908%	-0.908%
2.4	Centralized Energy Mgmt System		-0.333%	-0.333%	-0.333%	-0.333%
2.5	ENERGY STAR Portfolio Manager					
2.6	HVAC upgrades (current CIP projects)					
2.7	High performance energy standards		-0.200%	-0.200%	-0.200%	-0.200%
2.8	Onsite renewables		-1.000%			
2.9	Renewable electric purchased (kWh)		4.740%	3.740%	3.740%	8.640%
2.10	IIT's Technology Energy Plan (kWh only)					
2.11	Traffic lights to LED (kWh only)					
2.12	Guidelines for County leased space		-0.071%	-0.071%	-0.071%	-0.071%
2.13	Regulate # of personal appliances					
2.14	Roofing materials					
2.15	Third party commissioning		-0.357%	-0.357%	-0.357%	-0.357%
2.16	Consoldiation of government buildings					-4.900%
2.17	Future technology advancements		-1.667%	-1.667%	-1.667%	-1.667%
			0	0	0	0
			0.00%	0.00%	0.00%	0.00%
			-100.00%	-100.00%	-100.00%	**-100.00%**

BTU baseline Total DUSWM

		59,172,751,816				
		Adjusted Baseline	*0*	*0*	*0*	*0*
4.1	Landfill-to-Gas		6.000%	6.000%	6.000%	6.000%
4.2	Waste-to-Energy		-6.000%	-6.000%	-6.000%	-6.000%
4.3	Installation of solar technology					
			0	0	0	0
			-100.00%	-100.00%	-100.00%	-100.00%

Appendix J
Reduction by Annual Percentages - Cumulative Results

Natural Gas & Heating Oil Usage (BTUs)

BTU Baseline Total: 41,833,451,762

		NRE Affected	Year 1 FY2010	Year 2 FY2011	Year 3 FY2012
	Adjusted Baseline		*41,833,451,762*	*41,749,840,624*	*41,196,693,139*
1.1	BOCC and Management support	1.00%	-0.067%	-0.067%	-0.067%
1.2	Staff education	1.00%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations				
1.4	Annual report on progress				
2.1	Energy management program	1.00%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments				
2.3	Continous investment	7.40%			
2.4	Centralized Energy Mgmt System	4.00%			
2.5	ENERGY STAR Portfolio Manager				
2.6	HVAC upgrades (current CIP projects)	4.20%		-0.700%	-0.700%
2.7	High performance energy standards	2.00%			
2.8	Onsite renewables	4.00%			-1.000%
2.9	Renewable electric purchased (kWh)	15.00%			
2.10	IIT's Technology Energy Plan (kWh only)	3.20%			
2.11	Traffic lights to LED (kWh only)	0.50%			
2.12	Guidelines for County leased space	1.00%		-0.071%	-0.071%
2.13	Regulate # of personal appliances	0.10%			
2.14	Roofing materials	-0.02%		0.002%	0.002%
2.15	Third party commissioning	5.00%		-0.357%	-0.357%
2.16	Consolidation of government buildings	5.80%			
2.17	Future technology advancements	20.00%			
			41,749,840,624	41,196,693,139	40,244,365,612
			-0.20%	-1.32%	-2.31%
				-1.52%	-3.80%

	Baseline	Year 1 FY2010	Year 2 FY2011	Year 3 FY2012
DUSWM BASELINE - NATURAL GAS	4,853,500,000	4,853,500,000	4,853,500,000	4,853,500,000
TOTAL Baseline - NATURAL GAS Buildings & DUSWM	46,686,951,762	46,603,340,624	46,050,193,139	45,097,865,612
Buildings BASELINE - Generators	956,361,672	956,361,672	956,361,672	956,361,672

Appendix J
Reduction by Annual Percentages - Cumulative Results

Natural Gas & Heating Oil Usage (BTUs)

BTU Baseline Total:

		Year 4 FY2013	Year 5 FY2014	Year 6 FY2015	Year 7 FY2016
	41,833,451,762				
	Adjusted Baseline	*40,244,365,612*	*38,679,145,786*	*37,174,801,888*	*35,657,508,345*
1.1	BOCC and Management support	-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education	-0.067%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations				
1.4	Annual report on progress				
2.1	Energy management program	-0.067%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments				
2.3	Continous investment	-0.617%	-0.617%	-0.617%	-0.617%
2.4	Centralized Energy Mgmt System	-0.333%	-0.333%	-0.333%	-0.333%
2.5	ENERGY STAR Portfolio Manager				
2.6	HVAC upgrades (current CIP projects)	-0.700%	-0.700%	-0.700%	-0.700%
2.7	High performance energy standards			-0.200%	-0.200%
2.8	Onsite renewables				-2.000%
2.9	Renewable electric purchased (kWh)				
2.10	IIT's Technology Energy Plan (kWh only)				
2.11	Traffic lights to LED (kWh only)				
2.12	Guidelines for County leased space	-0.071%	-0.071%	-0.071%	-0.071%
2.13	Regulate # of personal appliances				
2.14	Roofing materials	0.002%	0.002%	0.002%	0.002%
2.15	Third party commissioning	-0.357%	-0.357%	-0.357%	-0.357%
2.16	Consolidation of government buildings				
2.17	Future technology advancements	-1.667%	-1.667%	-1.667%	-1.667%
		38,679,145,786	37,174,801,888	35,657,508,345	33,518,100,435
		-3.89%	-3.89%	-4.08%	-6.00%
		-7.54%	-11.14%	-14.76%	-19.88%
	DUSWM BASELINE - NATURAL GAS				
	4,853,500,000	4,853,500,000	4,853,500,000	4,853,500,000	4,853,500,000
	TOTAL Baseline - NATURAL GAS Buildings & DUSWM	43,532,645,786	42,028,301,888	40,511,008,345	38,371,600,435
	46,686,951,762				
	Buildings BASELINE - Generators				
	956,361,672	956,361,672	956,361,672	956,361,672	956,361,672

Appendix J
Reduction by Annual Percentages - Cumulative Results

Natural Gas & Heating Oil Usage (BTUs)

		Year 8 FY2017	Year 9 FY2018	Year 10 FY2019	Year 11 FY2020
BTU Baseline Total:	41,833,451,762				
	Adjusted Baseline	*33,518,100,435*	*32,376,692,402*	*31,274,153,287*	*30,209,159,468*
1.1	BOCC and Management support	-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education	-0.067%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations				
1.4	Annual report on progress				
2.1	Energy management program	-0.067%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments				
2.3	Continous investment	-0.617%	-0.617%	-0.617%	-0.617%
2.4	Centralized Energy Mgmt System	-0.333%	-0.333%	-0.333%	-0.333%
2.5	ENERGY STAR Portfolio Manager				
2.6	HVAC upgrades (current CIP projects)				
2.7	High performance energy standards	-0.200%	-0.200%	-0.200%	-0.200%
2.8	Onsite renewables				
2.9	Renewable electric purchased (kWh)				
2.10	IIT's Technology Energy Plan (kWh only)				
2.11	Traffic lights to LED (kWh only)				
2.12	Guidelines for County leased space	-0.071%	-0.071%	-0.071%	-0.071%
2.13	Regulate # of personal appliances				
2.14	Roofing materials	0.002%	0.002%	0.002%	0.002%
2.15	Third party commissioning	-0.357%	-0.357%	-0.357%	-0.357%
2.16	Consolidation of government buildings				
2.17	Future technology advancements	-1.667%	-1.667%	-1.667%	-1.667%
		32,376,692,402	31,274,153,287	30,209,159,468	29,180,432,397
		-3.41%	-3.41%	-3.41%	-3.41%
		-22.61%	-25.24%	-27.79%	-30.25%

DUSWM BASELINE - NATURAL GAS	4,853,500,000	4,853,500,000	4,853,500,000	4,853,500,000	4,853,500,000
TOTAL Baseline - NATURAL GAS Buildings & DUSWM	46,686,951,762	37,230,192,402	36,127,653,287	35,062,659,468	34,033,932,397
Buildings BASELINE - Generators	956,361,672	956,361,672	956,361,672	956,361,672	956,361,672

Appendix J
Reduction by Annual Percentages - Cumulative Results

Natural Gas & Heating Oil Usage (BTUs)

BTU Baseline Total:

			Year 12 FY2021	Year 13 FY2022	Year 14 FY2023	Year 15 FY2024
		41,833,451,762				
		Adjusted Baseline	*29,180,432,397*	*27,905,427,803*	*26,955,689,930*	*26,038,275,592*
1.1	BOCC and Management support		-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education		-0.067%	-0.067%	-0.067%	-0.067%
1.3	Energy conservation expectations					
1.4	Annual report on progress					
2.1	Energy management program		-0.067%	-0.067%	-0.067%	-0.067%
2.2	Building Assessments					
2.3	Continous investment		-0.617%	-0.617%	-0.617%	-0.617%
2.4	Centralized Energy Mgmt System		-0.333%	-0.333%	-0.333%	-0.333%
2.5	ENERGY STAR Portfolio Manager					
2.6	HVAC upgrades (current CIP projects)					
2.7	High performance energy standards		-0.200%	-0.200%	-0.200%	-0.200%
2.8	Onsite renewables		-1.000%			
2.9	Renewable electric purchased (kWh)					
2.10	IIT's Technology Energy Plan (kWh only)					
2.11	Traffic lights to LED (kWh only)					
2.12	Guidelines for County leased space		-0.071%	-0.071%	-0.071%	-0.071%
2.13	Regulate # of personal appliances					
2.14	Roofing materials					
2.15	Third party commissioning		-0.357%	-0.357%	-0.357%	-0.357%
2.16	Consolidation of government buildings					-5.800%
2.17	Future technology advancements		-1.667%	-1.667%	-1.667%	-1.667%
			27,905,427,803	26,955,689,930	26,038,275,592	23,693,263,770
			-4.37%	-3.40%	-3.40%	-9.01%
			-33.29%	-35.56%	-37.76%	**-43.36%**
	DUSWM BASELINE - NATURAL GAS					
		4,853,500,000	4,853,500,000	4,853,500,000	4,853,500,000	4,853,500,000
	TOTAL Baseline - NATURAL GAS Buildings & DUSWM		32,758,927,803	31,809,189,930	30,891,775,592	28,546,763,770
		46,686,951,762				**-38.85%**
	Buildings BASELINE - Generators					
		956,361,672	956,361,672	956,361,672	956,361,672	956,361,672

Appendix J
Reduction by Annual Percentages - Cumulative Results

Vehicle Fuel (BTUs)

BTU Baseline Total:

134,164,150,586

			Year 1 FY2010	Year 2 FY2011	Year 3 FY2012
	Adjusted Baseline		*134,164,150,586*	*122,596,572,083*	*111,169,313,342*
1.1	BOCC and Management support	1.00%	-0.067%	-0.067%	-0.067%
1.2	Staff education	1.00%	-0.067%	-0.067%	-0.067%
3.1	Fuel conservation plan	8.50%	-8.500%		
3.2	Biodiesel (12.3% Yr 7)	9.20%		-9.200%	
3.3	Purchase of hybrid vehicles (Gasoline)	1.50%			-0.115%
3.4	Hybrid Transit buses (Diesel)	4.00%			-0.308%
3.5	Down-size vehicles	10.00%			-0.769%
3.6	Teleconferencing	0.20%			-0.200%
3.7	Future technology advancements	15.00%			
			122,596,572,083	111,169,313,342	109,482,024,828
			-8.62%	-9.32%	-1.52%
				-17.14%	-18.40%

Overall Reduction - All Energy Sources Combined

	Year 1 FY2010	Year 2 FY2011	Year 3 FY2012
Total baseline BTU's: 318,296,312,377			
BTU's at end of Fiscal Year	305,256,008,529	244,009,596,193	238,653,409,778
Percent reduction from baseline BTU's	**-4.10%**	**-23.34%**	**-25.02%**

Appendix J
Reduction by Annual Percentages - Cumulative Results

Vehicle Fuel (BTUs)

BTU Baseline Total:

		Year 4 FY2013	Year 5 FY2014	Year 6 FY2015	Year 7 FY2016
	134,164,150,586				
	Adjusted Baseline	*109,482,024,828*	*106,685,962,990*	*103,961,309,786*	*101,306,241,510*
1.1	BOCC and Management support	-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education	-0.067%	-0.067%	-0.067%	-0.067%
3.1	Fuel conservation plan				
3.2	Biodiesel (12.3% Yr 7)				-3.100%
3.3	Purchase of hybrid vehicles (Gasoline)	-0.115%	-0.115%	-0.115%	-0.115%
3.4	Hybrid Transit buses (Diesel)	-0.308%	-0.308%	-0.308%	-0.308%
3.5	Down-size vehicles	-0.769%	-0.769%	-0.769%	-0.769%
3.6	Teleconferencing				
3.7	Future technology advancements	-1.250%	-1.250%	-1.250%	-1.250%
		106,685,962,990	103,961,309,786	101,306,241,510	95,658,692,621
		-2.55%	-2.55%	-2.55%	-5.57%
		-20.48%	-22.51%	-24.49%	-28.70%

Overall Reduction - All Energy Sources Combined

Total baseline BTU's: 318,296,312,377				
BTU's at end of Fiscal Year	221,134,683,381	214,492,569,491	207,901,799,840	134,986,654,728
Percent reduction from baseline BTU's	**-30.53%**	**-32.61%**	**-34.68%**	**-57.59%**

Appendix J
Reduction by Annual Percentages - Cumulative Results

Vehicle Fuel (BTUs)

BTU Baseline Total:

		Year 8 FY2017	Year 9 FY2018	Year 10 FY2019	Year 11 FY2020
	134,164,150,586				
	Adjusted Baseline	*95,658,692,621*	*93,215,664,916*	*90,835,029,704*	*88,515,193,544*
1.1	BOCC and Management support	-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education	-0.067%	-0.067%	-0.067%	-0.067%
3.1	Fuel conservation plan				
3.2	Biodiesel (12.3% Yr 7)				
3.3	Purchase of hybrid vehicles (Gasoline)	-0.115%	-0.115%	-0.115%	-0.115%
3.4	Hybrid Transit buses (Diesel)	-0.308%	-0.308%	-0.308%	-0.308%
3.5	Down-size vehicles	-0.769%	-0.769%	-0.769%	-0.769%
3.6	Teleconferencing				
3.7	Future technology advancements	-1.250%	-1.250%	-1.250%	-1.250%
		93,215,664,916	90,835,029,704	88,515,193,544	86,254,603,688
		-2.55%	-2.55%	-2.55%	-2.55%
		-30.52%	-32.30%	-34.02%	-35.71%

Overall Reduction - All Energy Sources Combined

Total baseline BTU's: 318,296,312,377				
BTU's at end of Fiscal Year	131,402,218,989	127,919,044,663	124,534,214,684	121,244,897,757
Percent reduction from baseline BTU's	**-58.72%**	**-59.81%**	**-60.87%**	**-61.91%**

Appendix J
Reduction by Annual Percentages - Cumulative Results

Vehicle Fuel (BTUs)

BTU Baseline Total:

	134,164,150,586	**Year 12 FY2021**	**Year 13 FY2022**	**Year 14 FY2023**	**Year 15 FY2024**
	Adjusted Baseline	*86,254,603,688*	*84,051,747,045*	*81,905,149,166*	*79,813,373,258*
1.1	BOCC and Management support	-0.067%	-0.067%	-0.067%	-0.067%
1.2	Staff education	-0.067%	-0.067%	-0.067%	-0.067%
3.1	Fuel conservation plan				
3.2	Biodiesel (12.3% Yr 7)				
3.3	Purchase of hybrid vehicles (Gasoline)	-0.115%	-0.115%	-0.115%	-0.115%
3.4	Hybrid Transit buses (Diesel)	-0.308%	-0.308%	-0.308%	-0.308%
3.5	Down-size vehicles	-0.769%	-0.769%	-0.769%	-0.769%
3.6	Teleconferencing				
3.7	Future technology advancements	-1.250%	-1.250%	-1.250%	-1.250%
		84,051,747,045	81,905,149,166	79,813,373,258	77,775,019,223
		-2.55%	-2.55%	-2.55%	-2.55%
		-37.35%	-38.95%	-40.51%	-42.03%

Overall Reduction - All Energy Sources Combined

Total baseline BTU's:				
318,296,312,377				
BTU's at end of Fiscal Year	117,767,036,520	114,670,700,768	111,661,510,521	107,278,144,665
Percent reduction from baseline BTU's	**-63.00%**	**-63.97%**	**-64.92%**	**-66.30%**

Appendix K

Appendix K

COMPREHENSIVE ENERGY PLAN
INVESTMENT AND SAVINGS CHART

This chart should be used as a general guide to potential costs and savings from the implementation of this Plan. It is not 100% comprehensive because some capital costs are unknown (for example, the costs of future on-site renewable energy production). This chart tracks the SUM of all investments that can be reasonably projected as well as the SUM of ongoing savings and ongoing expenses over the 15-year life of the Plan. It includes one-time costs in the year of the initial investment with the exception of the new building cost in Recommendation 2.16 which is amortized over 20 years and represented as an ongoing cost. Ongoing expenses and savings would continue after Year 15 but one-time costs would not, unless additional initiatives are undertaken.

- All costs and savings are in current dollars.
- Actual results will vary depending on which recommendations are implemented, the timing of implementation, funding for the Plan, and the advances made in energy technologies over time.
- Some capital costs (like a new consolidated office building) would provide benefits which may have value beyond just increasing energy efficiencies.
- Projections become increasingly less predictable/reliable the further out in time the projection goes.

Appendix K
Annual Projected Costs and On-going Savings

Staff time not included in estimates

	RECOMMENDATIONS	15 Year Total			Year 1 - FY2010			Year 2 - FY2011			Year 3 - FY2012			Year 4 - FY2013			Year 5 - FY2014			
		1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	
	Organizational Commitment																			
1.1	BOCC and Management Support			408,000			3,400			6,800			10,200			13,600			17,000	1.1
1.2	Staff education			408,000			3,400			6,800			10,200			13,600			17,000	1.2
1.3	Energy conservation expectations																			1.3
1.4	Annual report on progress (80 hrs staff time)																			1.4
	Building Recommendations																			
2.1	Energy management program			387,800						27,700			27,700			27,700			27,700	2.1
2.2	Building assessments	67,250		0	47,250						20,000									2.2
2.3	Continuous Investment	3,000,000	0	1,852,500										250,000		23,750	250,000		47,500	2.3
2.4	Centralized Energy Management System	1,500,000	0	725,400										125,000		9,300	125,000		18,600	2.4
2.5	ENERGY STAR Portfolio Manager																			2.5
2.6	HVAC upgrades	0	0	1,698,600						4,900			15,700			86,800			140,200	2.6
2.7	High performance energy standards (major renos)	1,000,000	0	247,500																2.7
2.8	Onsite renewable	unknown	unknown	798,000								?	22,800			22,800			22,800	2.8
2.9	Renewable electric purchased	0	5,046,000	0											80,000			80,000		2.9
2.10	IIT's Technology Energy Plan	471,000	0	1,561,800	471,000					94,100			112,900			112,900			112,900	2.10
2.11	Traffic lights to LED	40,000	0	217,100							40,000		16,700			16,700			16,700	2.11
2.12	Guidelines for County leased space	unknown	unknown	210,000				?		2,000			4,000			6,000			8,000	2.12
2.13	Regulate # of personal appliances	0	0	37,800						2,700			2,700			2,700			2,700	2.13
2.14	Roofing materials (TPO incremental costs)	97,100	0	112,000				30,700		8,000	4,700		8,000	43,400		8,000	5,800		8,000	2.14
2.15	Third party commissioning	299,600	0	850,500				21,400		8,100	21,400		16,200	21,400		24,300	21,400		32,400	2.15
2.16	Consolidation of government office buildings	0	1,668,000	140,720																2.16
2.17	Future technology advancements	unknown	unknown	2,230,800												28,600			57,200	2.17
	Fleet Recommendations																			
3.1	Fuel conservation plan	0	0	3,332,700			203,000			223,550			223,550			223,550			223,550	3.1
3.2	Biodiesel (B20/B5) Based on current usage	8,000	2,187,000	0				8,000	108,000			108,000			108,000			108,000		3.2
3.3	Purchase of hybrid vehicles	0	994,500	273,000								76,500	3,000		76,500	6,000		76,500	9,000	3.3
3.4	Hybrid Transit buses	460,000	0	686,200							40,000		9,400	40,000		18,800	20,000		23,500	3.4
3.5	Down-size vehicles (net savings - fuel)	0	0	1,920,100									21,100			42,200			63,300	3.5
3.6	Teleconferencing	0	1,040	78,000								80	6,000		80	6,000		80	6,000	3.6
3.7	Future technology advancements	600,000	0	2,683,200										50,000		34,400	50,000		68,800	3.7
	DUSWM Recommendations																			
4.1	Landfill-to-Gas	unknown	unknown	unknown																4.1
4.2	Waste-to-Energy	unknown	unknown	unknown																4.2
4.3	Installation of solar technology	unknown	unknown	unknown																4.3
		7,542,950	9,896,540	19,655,920																
	Annual Totals				518,250	0	209,800	60,100	108,000	384,650	126,100	184,580	510,150	529,800	264,580	727,700	472,200	264,580	922,850	
	TOTAL COST W/SAVINGS						308,450			-216,550			-199,470			66,680			-186,070	
	Cumulative Totals									91,900			-107,570			-40,890			-226,960	

Appendix K
Annual Projected Costs and On-going Savings

	Staff time not included in estimates RECOMMENDATIONS	Year 6 - FY2015			Year 7 - FY2016			Year 8 - FY2017			Year 9 - FY2018			Year 10 - FY2019			
		1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	
	Organizational Commitment																
1.1	BOCC and Management Support			20,400			23,800			27,200			30,600			34,000	1.1
1.2	Staff education			20,400			23,800			27,200			30,600			34,000	1.2
1.3	Energy conservation expectations																1.3
1.4	Annual report on progress (80 hrs staff time)																1.4
	Building Recommendations																
2.1	Energy management program			27,700			27,700			27,700			27,700			27,700	2.1
2.2	Building assessments																2.2
2.3	Continuous investment	250,000		71,250	250,000		95,000	250,000		118,750	250,000		142,500	250,000		166,250	2.3
2.4	Centralized Energy Management System	125,000		27,900	125,000		37,200	125,000		46,500	125,000		55,800	125,000		65,100	2.4
2.5	ENERGY STAR Portfolio Manager																2.5
2.6	HVAC upgrades			145,100			145,100			145,100			145,100			145,100	2.6
2.7	High performance energy standards (major renos)	100,000		4,500	100,000		9,000	100,000		13,500	100,000		18,000	100,000		22,500	2.7
2.8	Onsite renewable			22,800	?	?	68,400			68,400			68,400			68,400	2.8
2.9	Renewable electric purchased		80,000			534,000			534,000			534,000			534,000		2.9
2.10	IIT's Technology Energy Plan			112,900			112,900			112,900			112,900			112,900	2.10
2.11	Traffic lights to LED			16,700			16,700			16,700			16,700			16,700	2.11
2.12	Guidelines for County leased space			10,000			12,000			14,000			16,000			18,000	2.12
2.13	Regulate # of personal appliances			2,700			2,700			2,700			2,700			2,700	2.13
2.14	Roofing materials (TPO incremental costs)	12,500		8,000			8,000			8,000			8,000			8,000	2.14
2.15	Third party commissioning	21,400		40,500	21,400		48,600	21,400		56,700	21,400		64,800	21,400		72,900	2.15
2.16	Consolidation of government office buildings																2.16
2.17	Future technology advancements			85,800			114,400			143,000			171,600			200,200	2.17
	Fleet Recommendations																
3.1	Fuel conservation plan			223,550			223,550			223,550			223,550			223,550	3.1
3.2	Biodiesel (B20/B5) Based on current usage		108,000			183,000			183,000			183,000			183,000		3.2
3.3	Purchase of hybrid vehicles		76,500	12,000		76,500	15,000		76,500	18,000		76,500	21,000		76,500	24,000	3.3
3.4	Hybrid Transit buses	40,000		32,900	20,000		37,600	20,000		42,300	40,000		51,700	20,000		56,400	3.4
3.5	Down-size vehicles (net savings - fuel)			84,400			105,500			126,600			147,700			168,800	3.5
3.6	Teleconferencing		80	6,000		80	6,000		80	6,000		80	6,000		80	6,000	3.6
3.7	Future technology advancements	50,000		103,200	50,000		137,600	50,000		172,000	50,000		206,400	50,000		240,800	3.7
	DUSWM Recommendations																
4.1	Landfill-to-Gas																4.1
4.2	Waste-to-Energy																4.2
4.3	Installation of solar technology																4.3
	Annual Totals	598,900	264,580	1,078,700	566,400	793,580	1,270,550	566,400	793,580	1,416,800	586,400	793,580	1,567,750	566,400	793,580	1,714,000	
	TOTAL COST W/SAVINGS			-215,220			89,430			-56,820			-187,770			-354,020	
	Cumulative Totals			-442,180			-352,750			-409,570			-597,340			-951,360	

Appendix K
Annual Projected Costs and On-going Savings

Staff time not included in estimates		Year 11 - FY2020			Year 12 - FY2021			Year 13 - FY2022			Year 14 - FY2023			Year 15 - FY2024			
	RECOMMENDATIONS	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	1x Costs	On-going Costs	On-going Savings	
Organizational Commitment																	
1.1	BOCC and Management Support			37,400			40,800			44,200			47,600			51,000	1.1
1.2	Staff education			37,400			40,800			44,200			47,600			51,000	1.2
1.3	Energy conservation expectations																1.3
1.4	Annual report on progress (80 hrs staff time)																1.4
Building Recommendations																	
2.1	Energy management program			27,700			27,700			27,700			27,700			27,700	2.1
2.2	Building assessments																2.2
2.3	Continuous investment	250,000		190,000	250,000		213,750	250,000		237,500	250,000		261,250	250,000		285,000	2.3
2.4	Centralized Energy Management System	125,000		74,400	125,000		83,700	125,000		93,000	125,000		102,300	125,000		111,600	2.4
2.5	ENERGY STAR Portfolio Manager																2.5
2.6	HVAC upgrades			145,100			145,100			145,100			145,100			145,100	2.6
2.7	High performance energy standards (major renos)	100,000		27,000	100,000		31,500	100,000		36,000	100,000		40,500	100,000		45,000	2.7
2.8	Onsite renewable			68,400	?	?	91,200			91,200			91,200			91,200	2.8
2.9	Renewable electric purchased		534,000			534,000			534,000			534,000			534,000		2.9
2.10	IIT's Technology Energy Plan			112,900			112,900			112,900			112,900			112,900	2.10
2.11	Traffic lights to LED			16,700			16,700			16,700			16,700			16,700	2.11
2.12	Guidelines for County leased space			20,000			22,000			24,000			26,000			28,000	2.12
2.13	Regulate # of personal appliances			2,700			2,700			2,700			2,700			2,700	2.13
2.14	Roofing materials (TPO incremental costs)			8,000			8,000			8,000			8,000			8,000	2.14
2.15	Third party commissioning	21,400		81,000	21,400		89,100	21,400		97,200	21,400		105,300	21,400		113,400	2.15
2.16	Consolidation of government office buildings											834,000			834,000	140,720	2.16
2.17	Future technology advancements			228,800			257,400			286,000			314,600			343,200	2.17
Fleet Recommendations																	
3.1	Fuel conservation plan			223,550			223,550			223,550			223,550			223,550	3.1
3.2	Biodiesel (B20/B5) Based on current usage		183,000			183,000			183,000			183,000			183,000		3.2
3.3	Purchase of hybrid vehicles		76,500	27,000		76,500	30,000		76,500	33,000		76,500	36,000		76,500	39,000	3.3
3.4	Hybrid Transit buses	20,000		61,100	40,000		70,500	40,000		79,900	60,000		94,000	60,000		108,100	3.4
3.5	Down-size vehicles (net savings - fuel)			189,900			211,000			232,100			253,200			274,300	3.5
3.6	Teleconferencing		80	6,000		80	6,000		80	6,000		80	6,000		80	6,000	3.6
3.7	Future technology advancements	50,000		275,200	50,000		309,600	50,000		344,000	50,000		378,400	50,000		412,800	3.7
DUSWM Recommendations																	
4.1	Landfill-to-Gas																4.1
4.2	Waste-to-Energy																4.2
4.3	Installation of solar technology																4.3
	Annual Totals	**566,400**	**793,580**	**1,860,250**	**586,400**	**793,580**	**2,034,000**	**586,400**	**793,580**	**2,184,950**	**606,400**	**1,627,580**	**2,340,600**	**606,400**	**1,627,580**	**2,636,970**	
	TOTAL COST W/SAVINGS			-500,270			-654,020			-804,970			-106,620			-402,990	
	Cumulative Totals			-1,451,630			-2,105,650			-2,910,620			-3,017,240			-3,420,230	

Glossary

GLOSSARY

American Society of Heating, Refrigerating & Air-Conditioning Engineers (ASHRAE) – international organization that develops standards for uniform testing and rating of heating, ventilation, air-conditioning and refrigeration equipment. It also conducts related research, disseminates publications and provides continuing education to its members.

Anaerobic – living in the absence of air or free oxygen, or a chemical reaction or process not dependent on the presence of oxygen.

Ballast – part of a fluorescent light fixture that supplies initial electricity to the bulb and regulates electricity flow

Battery – device that stores energy and furnishes electric current upon demand

Bio-diesel –a blend of bio-fuel and petroleum diesel which can be used in compression-ignition (diesel) engines

Bio-fuel – fuel produced from plant and organic-based compounds.

Biogenic – resulting from the activity of living organisms, as fermentation; produced by living organisms or biological processes.

Biomass – a renewable energy source derived from organic materials including plant matter and animal waste that is usually incinerated to produce electricity

British thermal units (Btu) – a unit of energy equal to the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at one atmospheric pressure.

Carbon Dioxide (CO_2) – a compound carbon and oxygen generated as a by-product of the combustion of fossil fuels or the burning of vegetable matter; is an acidic oxide; toxic in high concentrations

Carbon monoxide (CO) – an odorless, colorless and toxic gas that results from incomplete oxidation of carbon in combustion; burns with a violet flame

Commissioning – quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria

Compressed natural gas (CNG) – a natural gas that is under pressure, remains clear, odorless and non-corrosive and is often used as an environmentally friendly substitute for gasoline or diesel

Condenser coils – soft aluminum tubes in an HVAC unit through which refrigerant flows so it can be cooled, allowing for the transfer of heat more quickly

Conservation – the careful utilization of natural resources in order to prevent depletion (see also energy conservation)

Cool Roofs – roofs consisting of materials that very effectively reflect the sun's heat energy from the roof surface.

Demand Response Program – Demand response (also known as load response) is end-use customers reducing their use of electricity in response to power grid needs, economic signals from a competitive wholesale market or special retail rates.

Direct Current (DC) – electricity that flows in one direction steadily with constant strength, not used for long-distance power transmission

Economizer – mechanical devices intended to reduce energy consumption in buildings by recapturing heat from the building before air is exhausted to the outside or by using ambient air temperature outside to adjust building temperatures inside without requiring mechanical heating or cooling.

Fossil fuel – fuels such as oil, natural gas and coal that were naturally produced over long periods of time from the remains of living organisms.

Efficiency – a relative measure of the amount of energy required to do a task compared to the optimum means of accomplishing the same task.

Ethylene propylene diene monomer (EPDM) – high-density synthetic rubber used as a roofing material that is very durable, has great resistance to abrasives, tearing, solvents and high temperatures

Electric Vehicle (EV) – a vehicle propelled by an electric motor(s) powered by battery packs that can be recharged by plugging them into a power outlet.

Emissions – substances discharged into the air including by-products of internal combustion engines and power generating plants that are fired by coal, natural gas or oil.

Energy – (physics) a thermodynamic quantity equivalent to the capacity of a physical system to do work;

Energy conservation – is the practice of decreasing the quantity of energy used. It may be achieved through more efficient energy use, in which case energy use is decreased while achieving a similar outcome (e.g. improving insulation in exterior walls), or by a reduction in activities that consume energy (e.g. turning off lights when not in the room).

Energy Star – A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy developed to protect the environment through energy efficiency products and practices.

Ethanol – a liquid fuel produced through man-made processing of organic matter;

Flex Fuel Vehicle (FFV) – a vehicle designed to run on both gasoline and a blend of gasoline and ethanol; FFVs typically get about 20-30 percent fewer miles per gallon since ethanol contains less energy than gasoline

Fluorescent lights – lights where the source of light is produced by gas that glows when connected to electricity. Fluorescent light bulbs can have a very long life – between 8,000 and 20,000 hours. They use up to 75 percent less power than incandescent light bulbs.

Fuel cell – a device used for combining fuel and oxides to generate electricity. It is the conversion of chemicals to electrical energy.

Geothermal – refers to the utilization of the relatively constant below-grade temperatures of the earth for either heat extraction or heat rejection for HVAC systems in buildings.

Greenhouse gases (GHG) – any gas that absorbs infrared radiation in the atmosphere; includes water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20), halogenated fluorocarbons (HCFCs), ozone (03), perfluorinated carbons (PFCs) and hydrofluorocarbons (HFCs)

Heat pump – a machine or device that moves heat from one location (the 'source') to another location (the 'sink' or 'heat sink') using mechanical work. One common type of heat pump works by exploiting the physical properties of an evaporating and condensing fluid known as a refrigerant. Common examples are food refrigerators and freezers, air conditioners, and reversible-cycle heat pumps for providing thermal comfort.

Hybrid Electric Vehicle (HVE) – a vehicle propelled by an internal combustion engine and an electric motor(s);, the HVE converts energy normally wasted during coasting and braking into electricity, which is stored in the battery until needed by the electric motor.

Hydrocarbons (HC) – organic compounds that contain only carbon and hydrogen

Hydroelectricity – electricity generated from the power of moving water operating electrical turbines

Hydrogen – the most abundant element on earth yet hydrogen does not occur naturally; once separated from another element, hydrogen can be burned as a fuel or converted into electricity.

Improving energy efficiency – accomplishing a task with less energy; energy efficiency may be improved by changing-out older technology equipment with newer technology equipment (for example replacing 32-watt light fluorescent bulbs with 28-watt bulbs which produce equal light).

Incandescent light– lights where the source of the light is an electric current passing through a thin filament, heating it until it glows

Kilowatt hour (kWh) – measure of electricity equal to 1 kilowatt of power produced or used over 1 hour

Landfill Gas to Energy (LFG) – A process of burning the gases produced by decomposing waste in landfills to power electric generators

Leadership in Energy & Environmental Design (LEED) – A rating scale developed by the U.S. Green Building Council for measuring a building's impact on the environment and those that will occupy the building;

Light Emitting Diode (LED) – a light source that uses significantly less energy than traditional lighting because it produces light without significant waste heat

Maryland Renewable Portfolio Standard (RPS) – a Maryland statute that requires electricity suppliers (all utilities and competitive retail suppliers) to use renewable energy sources to generate a minimum portion of their retail sales. Beginning in 2006, electricity suppliers are required to provide 1% of retail electricity sales in the state from Tier 1 renewables and 2.5% from Tier 2 renewables. The renewable requirement increases gradually, ultimately reaching a level of 20% from Tier 1 resources in 2022 and beyond, and 2.5% from Tier 2 resources from 2006 through 2018. The Tier 2 requirement sunsets, dropping to 0% in 2019 and beyond

Megawatt (MW) – unit of energy equal to 1 million watts or 1,000 kilowatts

Methane (CH4) – odorless, colorless, flammable gas, released during decomposition of plant or other organic compounds; main component of marsh gas and frequently formed in coal mines; used as a source of fuel and an important source of hydrogen

Million Metric Tons of Carbon Equivalent (MMTCE) – also referred to as carbon equivalent. Metric measure used to compare the emissions of greenhouse gases based upon their global warming potential. The equivalent for gas is derived by multiplying the tons of gas by the associated global warming potential.

Natural gas – a fossil fuel that is a colorless and odorless gas

Non-renewable energy– of or relating to energy sources such as oil, natural gas, coal, uranium that are not replenishable, or that are produced naturally at a dramatically slower rate than current demand would utilize.

Northeast Maryland Waste Disposal Authority (NMWDA) – An independent State agency representing 7 Maryland counties and the City of Baltimore

Oxygenated fuel – fuel that has a chemical compound containing oxygen added to improve combustion efficiency and reduce some types of atmospheric pollution

Photovoltaic (PV) – direct conversion of light into electricity through solar cells

Portfolio Manager (provided by EPA) – An interactive energy management software application made available to the public by the EPA and DOE that tracks and assess energy and water consumption across an entire portfolio of buildings and provides a ranking of a building's energy efficiency compared to other buildings of a similar size and use taking into account regional and seasonal variations in the weather.

Renewable energy – energy produced from sources that can be used indefinitely or over very long periods of time without exhausting the supply if property managed such as solar energy, flowing water, geothermal heat, bio-fuels or wood.

Renewable Energy Credits (REC's) – marketable environmental commodities in the U.S. which represent proof of electricity was generated from eligible renewable energy resources

Seasonal Energy Efficiency Rating (SEER)/Energy Efficiency Rating (EER) – measures of the efficiency of air-conditioning systems; ratio of the annual BTU's of cooling provided divided by the electric energy input used and measured over a range of temperatures

Smart Client – is a term used to describe electronic data management through a 'virtual desktop infrastructure' that reduces electricity consumption by eliminating the need for the more traditional desktop computer hardware of local hard drives, external hardware ports and floppy drives.

Solar Cells – cells that convert sunlight directly into electricity and are made of semiconductors such as crystalline silicon or various thin-film materials

Solar Energy – heat and light energy produced by the sun

Solar Reflectance – measure of the ability of a surface material to reflect sunlight – including the visible, infrared, and ultraviolet wavelengths – scale of measure from 0 to 1. Also called albedo

Solid Waste Association of North America (SWANA) – leading professional association in the solid waste management field

Standard Planning Grade Energy Assessment– building assessments designed to identify and document energy-saving retrofit and upgrade opportunities

Sustainability – a lifestyle or the result of choices that meets the needs of the present without compromising the ability of future generations to meet their own needs; understand the interconnections of the economy, society and environment and supports equitable distribution of resources and opportunities

Thermal Energy – energy derived from heat

Therms – a unit of measure equal to 100,000 Btu's

Thermoplastic olefin (TPO) – blend of polymers with high reflective qualities used as a roofing material

Tier 1 Renewable sources – geothermal, hydro facilities under 30 MW, methane, ocean, qualifying biomass, solar, wind, and fuel cells

Tier 2 Renewable sources – municipal waste-to-energy projects, poultry litter, and existing hydro facilities over 30 MW

Variable Refrigerant Volume (VRV) HVAC System –a high efficiency HVAC system that moves or removes heat in spaces by varying the flow of refrigerant to individual units in each room, rather than the more traditional system of large volumes of air moving across central heat exchangers. VRV systems often include the capability to transfer heat within a building from an area needing cooling to an area requiring heat ; this system is sometimes referred to as a 'ductless system' since traditional large air ducts are not required.

Vegetated roof – a roof surface that is covered with plantings and landscape used primarily to increase the insulation value of the roof and to reduce storm water runoff.

Watt – unit of power equal to one joule per second and equal to the power in a circuit in which a current of one ampere flows across a potential difference of one volt

Wind power – Electricity generated by wind turbines turned by the kinetic energy of wind.